ORIGINAL

Memorandum

From the office of
Commissioner Bob Burns
Arizona Corporation Commission
1200 W. WASHINGTON
PHOENIX, ARIZONA
(602) 542-3682

Arizona Corporation Commission
DOCKETED
JUN 27 2014
DOCKETED BY

TO: Docket Control

DATE: June 27, 2014

FROM: Commissioner Bob Burns

SUBJECT: Emerging Technologies in Energy, Docket No. E-00000J-13-0375

The agenda and presentations from the June 25, 2014 Emerging Technologies Response Workshop have been docketed. If for some reason you cannot access eDocket, please contact my Executive Aide, Jessica Perry, to receive copies of the presentations.

Original and thirteen (13) copies of
the agenda and presentations filed this 27th day of
June, 2014, with:

Docket Control
Arizona Corporation Commission
1200 West Washington Street
Phoenix, Arizona 85007

Copies of the memo mailed
this 27th day of June, 2014, to:

Service List

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2014 JUN 27 A 10: 13
AZ CORP COMMISSION
DOCKET CONTROL

FOURTH REVISED N O T I C E
SPECIAL OPEN MEETING
OF THE ARIZONA CORPORATION COMMISSION

Commission Workshop on Emerging Technologies
Docket No. E-00000J-13-0375

DATE: Wednesday, June 25, 2014 **START TIME: 9:00 a.m.**

Arizona Corporation Commission
Hearing Room One
1200 W. Washington Street
Phoenix, Arizona 85007

This shall serve as notice of a special open meeting of the Arizona Corporation Commission at the above location for consideration, discussion, and possible vote of the items on the following agenda and other matters related thereto. Please be advised that the Commissioners may use this open meeting to ask questions about the matters on the agenda; therefore, the parties to the matters to be discussed or their legal representatives are requested, though not required, to attend. The Commissioners may move to executive session, which will not be open to the public, for the purpose of legal advice pursuant to A.R.S. §§ 38-431.03.A.2, 3 and/or 4 on the matters noticed herein. The Commissioners may also move to executive session, which will not be open to the public, for other purposes specified in A.R.S. §§ 38-431.03, including discussions, consultations or considerations of Commission personnel and salary matters, on matters noticed herein.

The Arizona Corporation Commission does not discriminate on the basis of disability in admission to its public meetings. Persons with a disability may request a reasonable accommodation, such as a sign language interpreter, as well as request this document in an alternative format, by contacting Shaylin A. Bernal, phone number (602) 542-3931, E-mail sabernal@azcc.gov. Requests should be made as early as possible to allow time to arrange the accommodations.

Jodi Jerich
Executive Director

Agenda

Welcome & Opening Remarks

Presentations:

1) Arizona Public Service
    a. Scott Bordenkircher, Director of Technology Innovation and Integration
       "Utilities and Microgrids"

2) Energy Savvy
    a. David Wolpa, Director of Client Solutions
       "Software Driving Energy Efficiency Scale and Measurability"

3) Meritage Homes
    a. Michael IlesCremieux, Regional Vice President of Land Acquisition
       "Meritage Homes: Setting the Standard for Energy-Efficient Homes"

4) International District Energy Association
    a. Rob Thornton, President & CEO
       "Microgrids: Moving into the Mainstream"

5) DNV GL
    a. Rich Barnes, Vice President and Global Director, Sustainable Energy Use
       "Sustainable Energy Use Technology"

6) Horizon Power Systems
    a. Vito Coletto, Corporate Accounts Director
       "Energy Efficiency Achieved with Microturbine Based Combined Heat and Power Systems (CHP)"

7) The Geothermal Exchange Organization
    a. Morgan Stine, Member of Geothermal Exchange Organization & President of Green Earth Energy & Environmental, Inc.
       "The Impact of Geothermal Heat Pumps on Energy Efficiency and Peak Demand"

8) EASCOR Hybrid Lighting System
    a. Wes Moyer, President & CTO
       "Hybrid Lighting Solutions by EASCOR"

Wrap-Up & Closing Remarks

Utilities & Microgrids

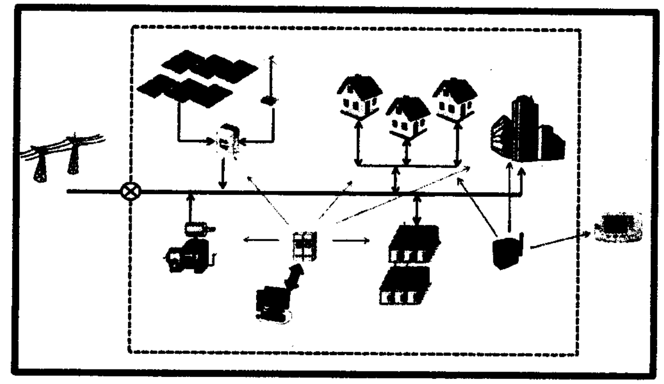
ACC Workshop on Emerging Technologies

Scott Bordenkircher
Director, Technology Innovation & Integration
June 25, 2014

aps

Microgrid Definition

A group of interconnected loads and distributed energy resources within clearly defined electrical boundaries that act as a single controllable entity with respect to the grid. A microgrid can connect and disconnect from the grid to enable it to operate in both grid-connected and island-mode.



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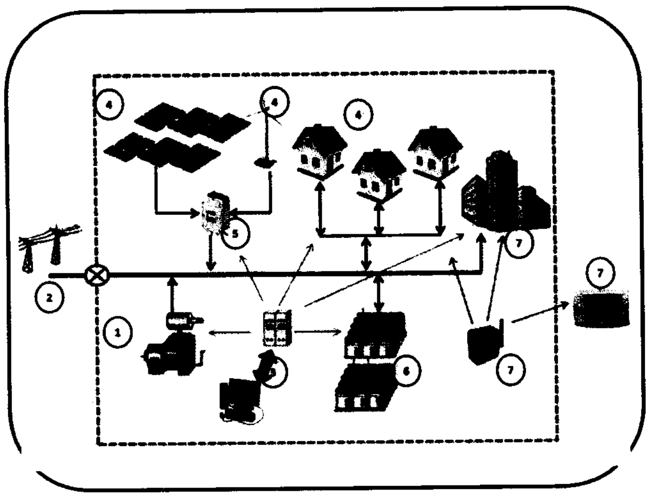
Building Blocks of a Microgrid

REQUIRED Elements

1. Dispatchable Energy Resources
2. Smart/Fast Switches
   - Common coupling between utility and microgrid
3. Advanced Controls

Optional Elements

4. Intermittent Energy Resources
5. Smart Islanding Inverters
   - Converts DC to AC
   - VAR/ voltage support
6. Energy Storage
7. Automated Demand Response



Controls and resources must, in aggregate, have the ability to: 1) manage transitions between grid-connected and island mode; 2) balance loads and resources; and 3) manage microgrid transient reliability and stability

Key Microgrid Design Requirements

- Generation Must Meet *Instantaneous* Load
- Generation Must be Dispatchable
- System Must Have a Comprehensive Control Scheme / Energy Management System
- System Must Have a Well-Coordinated System Protection Scheme
- Fuel Supply Must Meet Overall Resiliency Requirements

Major Customer Segments

- Utilities
- Universities and Campuses
- Military
- Data Centers
- Medical/Bio-tech
- Other Critical Infrastructure
- Remote Locations

Top Customer Microgrid Drivers

- Reliability
- Resiliency
- Economics
- Cyber & Physical Security
- Energy Independence

Top Utility Microgrid Drivers

- T&D Asset Deferral
- Capacity
- Economic Development
- Reliability
- Ancillary Services
  - Frequency response
  - Spinning reserves
  - Volt/ VAR support
- Customer Service

Why Utilities?

- In the business of planning, operating, and maintaining electrical generation and distribution assets
  - Protection and control
  - Generation characteristics
  - Electrical distribution design
  - Rate structures and asset valuations
  - Interconnection and grid integration/ interdependency
  - Expertise and resources
  - Long standing history of customer relationship

Active APS Efforts

- Carol Spring Mountain – 34KW; 1998
- Punkin Center – potential asset deferral
- Customer served thru National Forest
- Major University
- DOD Site

Questions?

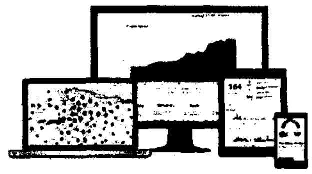
Scott Bordenkircher
Director, Technology Innovation & Integration

Scott.Bordenkircher@aps.com

EnergySavvy

Software Driving EE Scale and Measurability

David Wolpa, EnergySavvy
June 25, 2014



Agenda

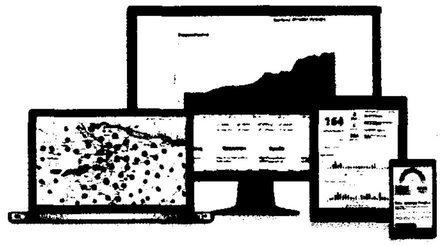
1	EnergySavvy Overview
2	Current EE Challenges
3	How Software Is Solving Them
4	Questions

EnergySavvy 2

What We Believe

Quantify and deliver energy efficiency through data transparency and control

- **Easy**
  Create experiences customers love
- **Scalable**
  More cost effective EE
- **Measurable**
  Impacts are measurable and timely so EE can be a resource



EnergySavvy 3

Optix Demand-side Management System

Cloud-based Software for Utility DSM

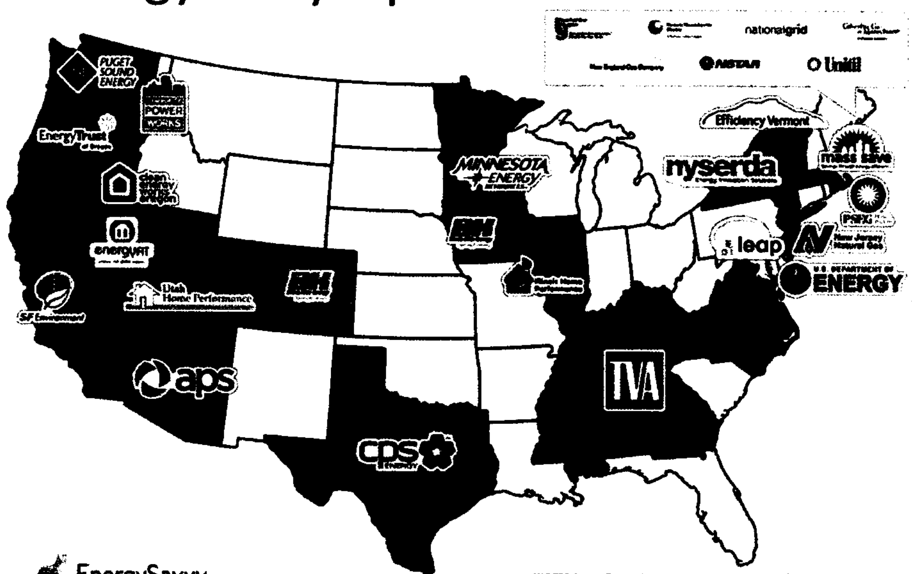
Engagement	Management	Quantification
Modern experiences that customers love	Increase cost effectiveness	Enhanced, "real-time" measurability of EE

API, Enterprise Hosting, Security, Disaster recovery, Standards

Utility Program	Customers	3rd Party Implementers	Trade Allies	EM&V	Regulatory	Grid

EnergySavvy 4

EnergySavvy Optix Users



EnergySavvy

NYSERDA uses EnergySavvy Optix in conjunction with CSG
Minnesota Energy uses EnergySavvy Optix in conjunction with AEG

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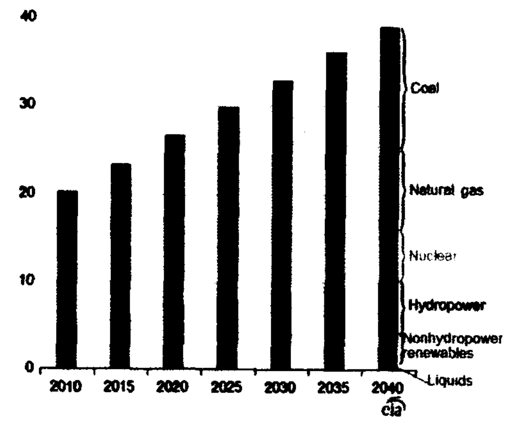
2. Current EE Challenges

Energy Efficiency is Critical

Figure 6. World net electricity generation by energy source, 2010-2040
trillion kilowatthours



World energy demand is projected to increase by 45% by 2030-- an average rate of increase of 1.6% per year-- with coal accounting for more than a third of the overall rise.

EnergySavvy

Source: U.S. Energy Information Administration (EIA), International Energy Outlook 2013

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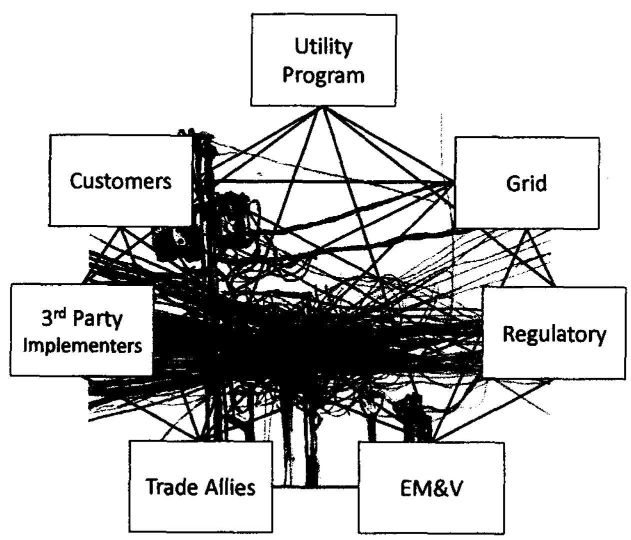
The World of EE Can Look Like This



EnergySavvy

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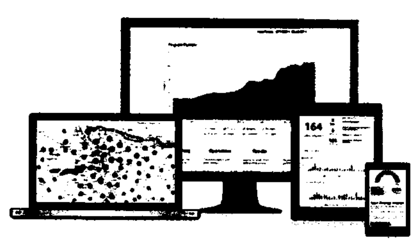
3. How Software is Solving EE Challenges

How Software is Solving EE Challenges

Engagement
Modern experiences that customers love

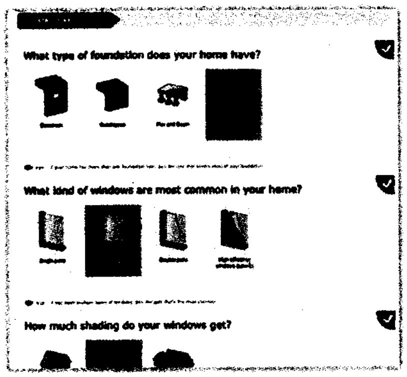
Management
Increase cost effectiveness

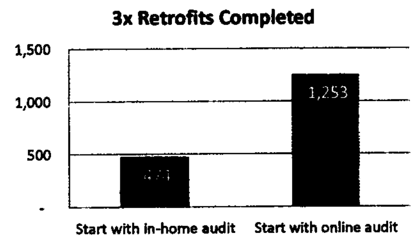
Quantification
Enhanced, "real-time" measurability of EE

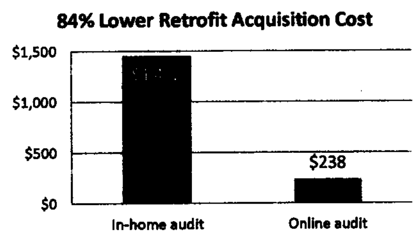


EnergySavvy

More Customer Participation







EnergySavvy

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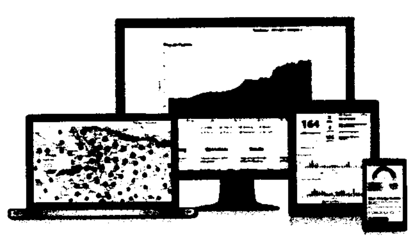
How Software is Solving EE Challenges

Engagement
Modern experiences that customers love

Management
Increase cost effectiveness

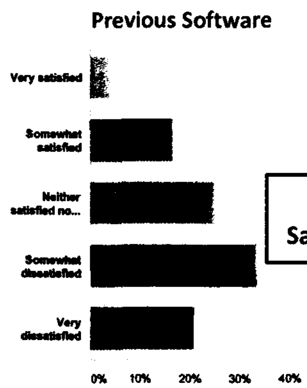
Quantification
Enhanced, "real-time" measurability of EE



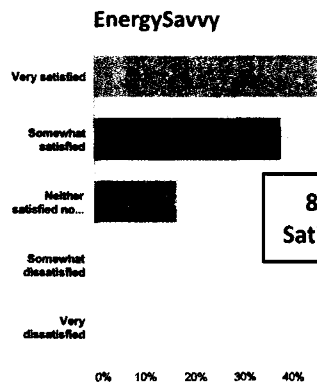
EnergySavvy

Trade Ally Satisfaction

aps



21% Satisfied



83% Satisfied

Contractor's also reported:
- 31% less admin time per project
- 50% more likely to submit jobs to APS

EnergySavvy

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Reducing Time & Costs

Utah Home Performance
ENERGY STAR

	Before EnergySavvy	After EnergySavvy	Improvement
Audit-to-test-out time period	103 days	62 days	40% faster
Audit-to-retrofit conversion rate	48%	70%	46% more
Up-front incentive $ per MBTU acquired*	$6.80	$5.27	23% cheaper

EnergySavvy

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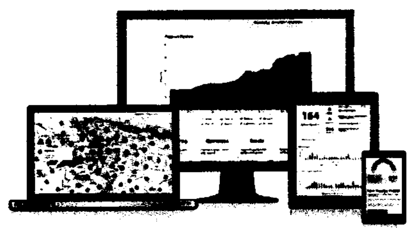
How Software is Solving EE Challenges

Engagement	Management	Quantification
Modern experiences that people love	Increase cost effectiveness	Enhanced, "real time" measurability of EE



EnergySavvy

Need to answer questions like:

1. How much is being saved and for how long?
2. What projects are the most cost effective, so we can do as many of those as possible?
3. Is my house worth more?

But can be hard to quantify energy that is not being used

EnergySavvy

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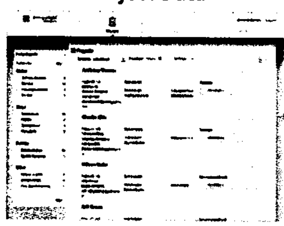
Leverage Smart Grid Data

Project Data **Smart Grid Data** **Weather Data**

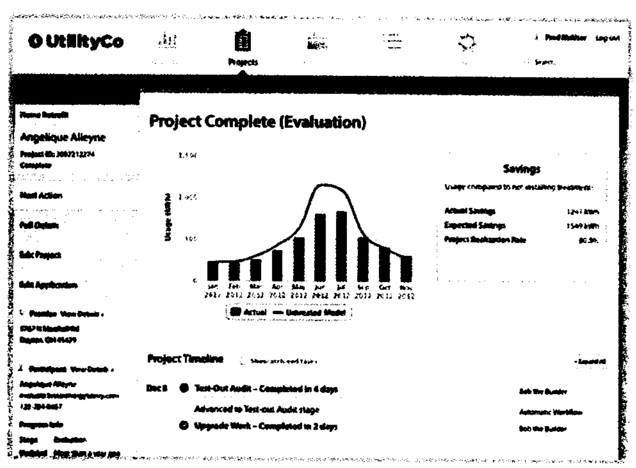


Data:
- Collected throughout program implementation
- Analyzed with advanced software

EnergySavvy 17

EE in Resource Planning

EE data in one place
- How much?
- Where?
- When?
- How long?

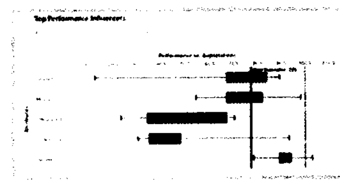


EnergySavvy 18

Making Programs More Cost Effective

Near Term

- Can more quickly identify what factors lead to the most cost effective projects and replicate that



Longer Term

- Factor EE into real estate prices
- Motivate customers to do EE without needing as much of a utility rebate

Congratulations! After your AC and insulation upgrade, your house used $600 less energy this year.

Your house could be worth up to $7,000 more than less efficient homes.

EnergySavvy

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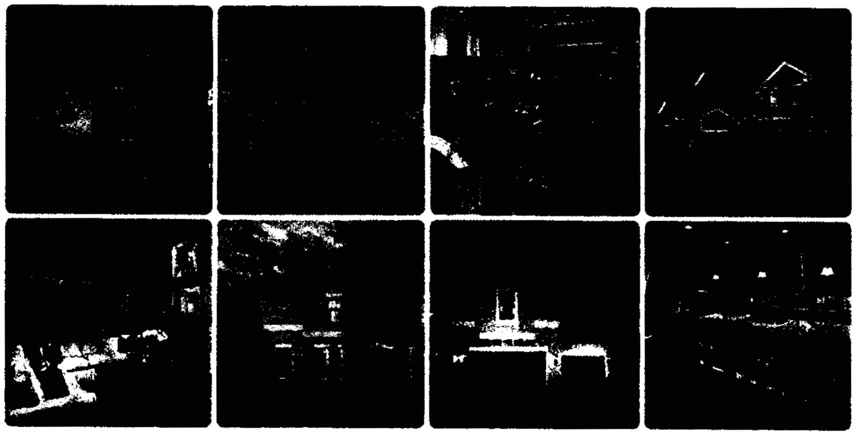
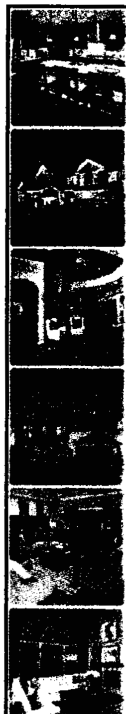
4. Q&A

Meritage Homes



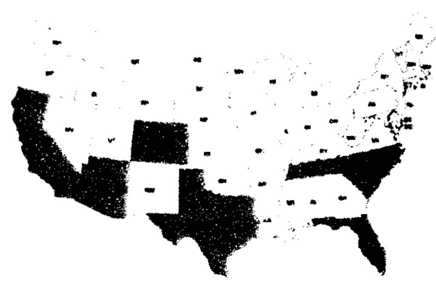
MeritageHomes CORPORATION

Setting the standard for energy-efficient homes™



Meritage Homes Corporate Profile

- Top-10 U.S. homebuilder by 2013 closings and growing market share
- 8 states -- 19 markets -- 188 actively selling communities at 12-31-13
- Recognized leader in energy-efficient homebuilding
- Published first CSR report for FYE 2012 last year



100% ENERGY STAR® certified homes since January 1, 2010

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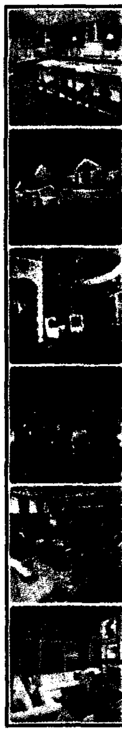

Energy policy has the potential to positively contribute to AZ economic prosperity and it's citizen's quality of life.

But ...

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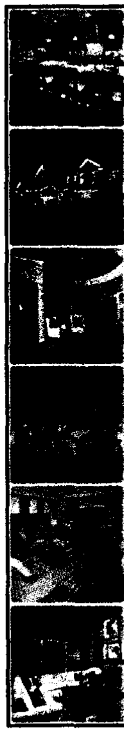

The industry needs to change to:

- Leverage economies of scale of innovation
- Educate stakeholders to drive better choices
- Manage to total cost of operation
  - Reduce waste
  - Initial cost vs monthly cost
  - Flattened / shifted load shape
  - Reduced total capacity requirements
- Change Transactions to leverage future benefits
  - Energy / Load Labeling
  - Improved predictive modeling
  - Improved controls
  - Realize total cost of operation in transaction
    - (appraisal / underwriting)

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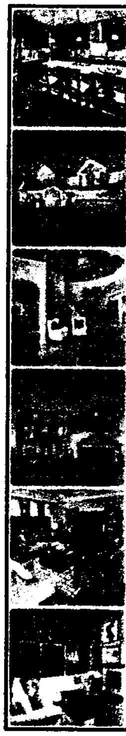

Sustainable Sustainability

- Creating Value to Consumers
- Creating Value to Utilities
- Creating value to the US
- Extracting Value
  - Builders
  - Buyers
  - Banks
  - Utilities
  - Economy

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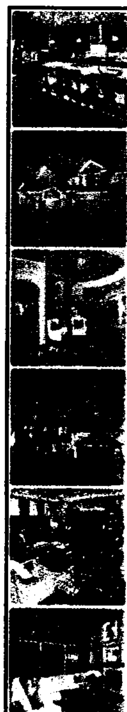
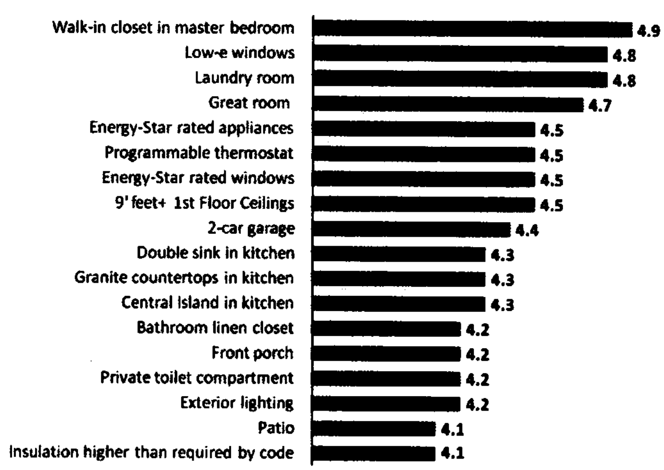


Progressing along the scale

MOST LIKELY Features in Typical Single-family Home in 2014
(1=Not at all likely, 5=very likely; avg. rating)



Source: NAHB EcHP Group, HMI Survey, December 2013.

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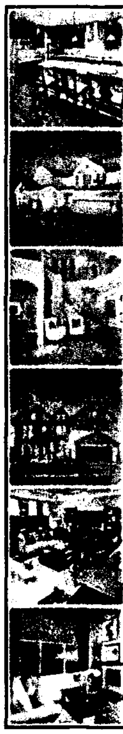
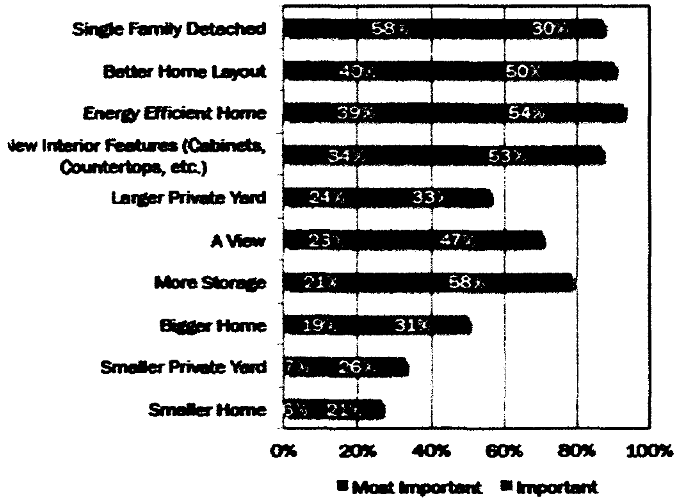


Consumer Choice drives change

Rate the importance of the following when purchasing your next home:



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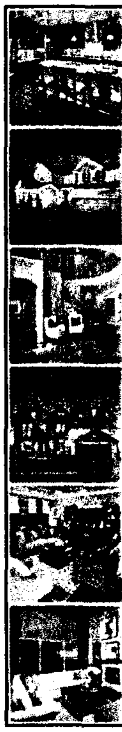
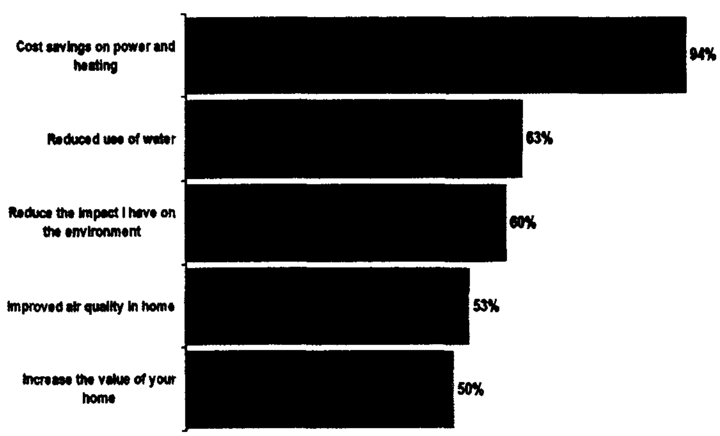


Consumer Focus

TOP 5 REASONS TO BUY GREEN HOME / MAKE GREEN IMPROVEMENTS TO HOME



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J.D. POWER AND ASSOCIATES

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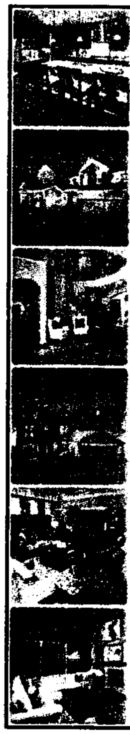

Creating Change

- Customer Quality of Life
  - Reduced Waste / Total Monthly Cost
  - Healthier
- Understanding 'Better'
  - Flatter Load Shapes (McKinsey EE Report)
  - Reduced Infrastructure sizing
  - Reduced projected load growth / expansion costs
- Establishing a Win-win
  - Optimized energy usage and demand to increase state productivity and COL

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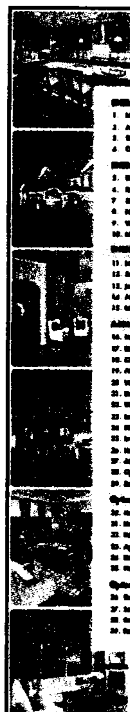
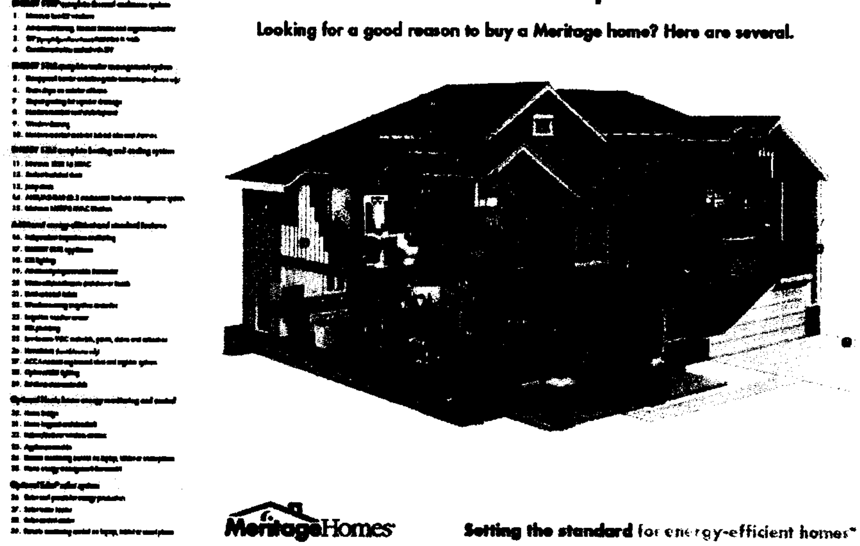


Standard Features Included at Competitive Prices



Energy-efficient features are standard in every home; entire system designed to maximize energy efficiency

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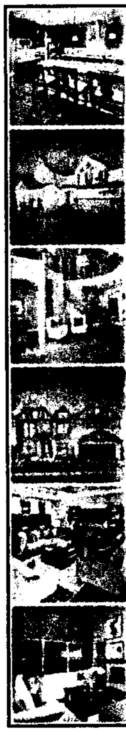
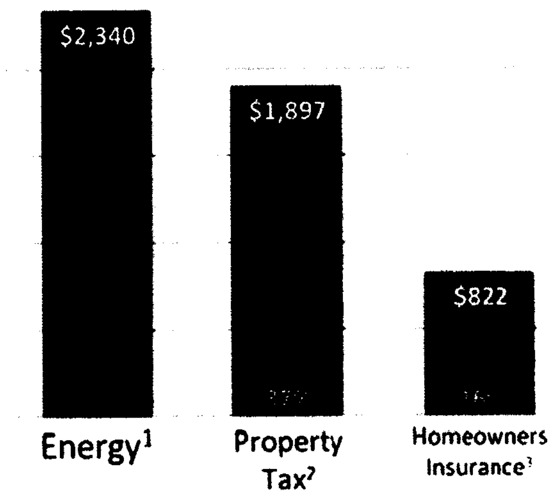


Average U.S. Homeowner Costs
2007-2008



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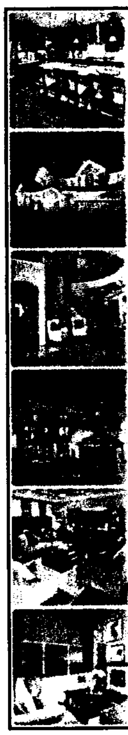

SRP PowerWise Homes™

Get the best energy value possible in energy-efficient SRP PowerWise Homes™, as featured by Meritage Homes.

General Information:

Conditioned Area:	**1840 sq.ft**
House Type:	**Single Family Detached**
Bedrooms:	**3**

Annual Estimated Energy Use

	Lyon's Gate	New to Code	Average Resale
Heating	$ 49	$ 101	$ 194
Cooling	$ 320	$ 645	$ 987
Hot Water	$ 2	$ 254	$ 266
Lights / Appliances	$ 517	$ 599	$608
Photovoltaics	($ 347)	($ 0)	($ 0)
Service Charge	$ 180	$180	$180
Total	$ 728	$1,779	$2,235

Your actual costs may be higher or lower than those illustrated, depending on individual lifestyle, number of persons living in the home and SRP's fuel cost adjustment factor. SRP reviews the adjustment factor every six months, with any change made effective on July 1st and/or November 1st

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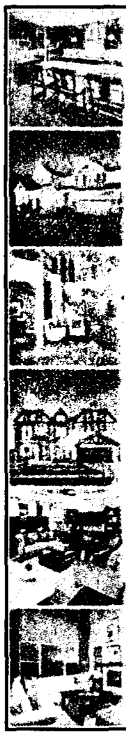
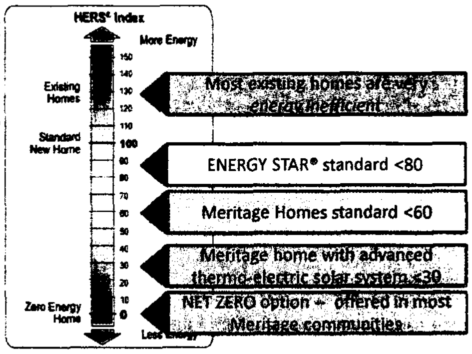


Setting the Standard
for Energy-Efficient Homes



Product Value - Better is Better

Low Utility Costs (Energy Label)

Healthier (VOCs, Merv 8, SPF, sealed attic)

More Comfortable (Low e2 windows, SPF, conditioned attic, TStat)

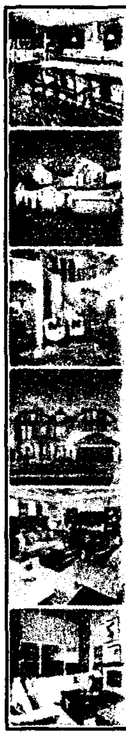
Cleaner (Merv 8, SPF, sealed attic)

Quieter (Low e2 Windows, SPF, sealed attic)

Safer (SPF, sealed attic, water management, Low Vocs)

Not Economically Reproducible in Resale

Recognized as ENERGY STAR® *Partner of the Year for Sustained Excellence in 2013* – their highest award



Residential Green and Energy Efficient Addendum

AI Reports® Form 820.08*	Client File #:	Appraisal File #:
	Residential Green and Energy Efficient Addendum	
	Client:	
	Subject Property:	
	City:	State: Zip:

Additional resources to aid in the valuation of green properties and the completion of this form can be found at http://www.appraisalinstitute.org/education/green_energy_addendum.aspx

ENERGY EFFICIENT ITEMS

The following items are considered within the appraised value of the subject property:

Insulation	☐ Fiberglass Blown-In ☐ Foam Insulation ☐ Cellulose ☐ Fiberglass Batt Insulation ☐ Other (Describe): ☐ Basement Insulation (Describe): ☐ Floor Insulation (Describe):			R-Value: ☐ Walls ☐ Ceiling ☐ Floor
Water Efficiency	☐ Reclaimed Water System (Explain): ☐ Rain Barrels - #:	☐ Cistern - Size: Gallons ☐ Rain Barrels Provide Irrigation		Location:
Windows	☐ ENERGY STAR® ☐ Low E	☐ High Impact ☐ Storm	☐ Double Pane ☐ Triple Pane	☐ Tinted ☐ Solar Shades
Day Lighting	☐ Skylights - #: ☐ Solar Tubes - #:	☐ ENERGY STAR Light Fixtures	☐ Other (Explain):	
Appliances	ENERGY STAR Appliances: ☐ Range/Top ☐ Dishwasher ☐ Refrigerator ☐ Other:	Water Heater: ☐ Solar ☐ Tankless (On Demand) Size: Gal.	Appliance Energy Source: ☐ Propane ☐ Electric ☐ Natural Gas ☐ Other (Describe):	
HVAC (Describe in Comments Area)	☐ High Efficiency HVAC - SEER: ☐ Programmable Thermostat	☐ Heat Pump ☐ Wind	☐ Thermostat/Controllers ☐ Radiant Floor Heat	☐ Passive Solar ☐ Geothermal
Energy Rating	☐ ENERGY STAR Home ☐ HPwES (Home Performance with ENERGY STAR) ☐ Other (Describe):		☐ Indoor Air PLUS Package ☐ Energy Recovery Ventilator Unit ☐ Certification Attached	

...mes

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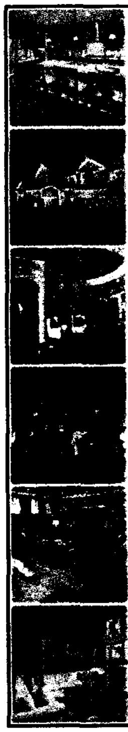
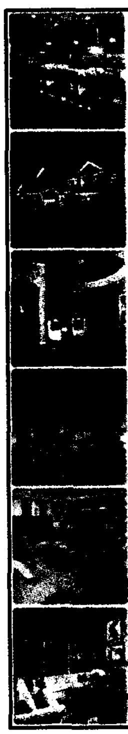


Work to be done:

- Consistent Labeling (consumer awareness)
- Energy Efficient mortgages (fund smart EE)
- Better load management
  - Reduce end of day peak
- Better energy models:
  - Predict and benefit from reduced peak loads
  - Better identify and promote peak load reduction strategies
- Define future state:
  - Idealized energy sources to optimize total kWh cost
  - Cost effective rehab / new build
- Sponsor change to move the industry on Win-Wins

MeritageHomes CORPORATION

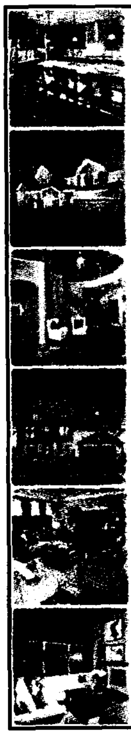
15



Questions?

MeritageHomes CORPORATION

16



Thank you!

Meritage Homes

www.MeritageHomes.com

MeritageHomes

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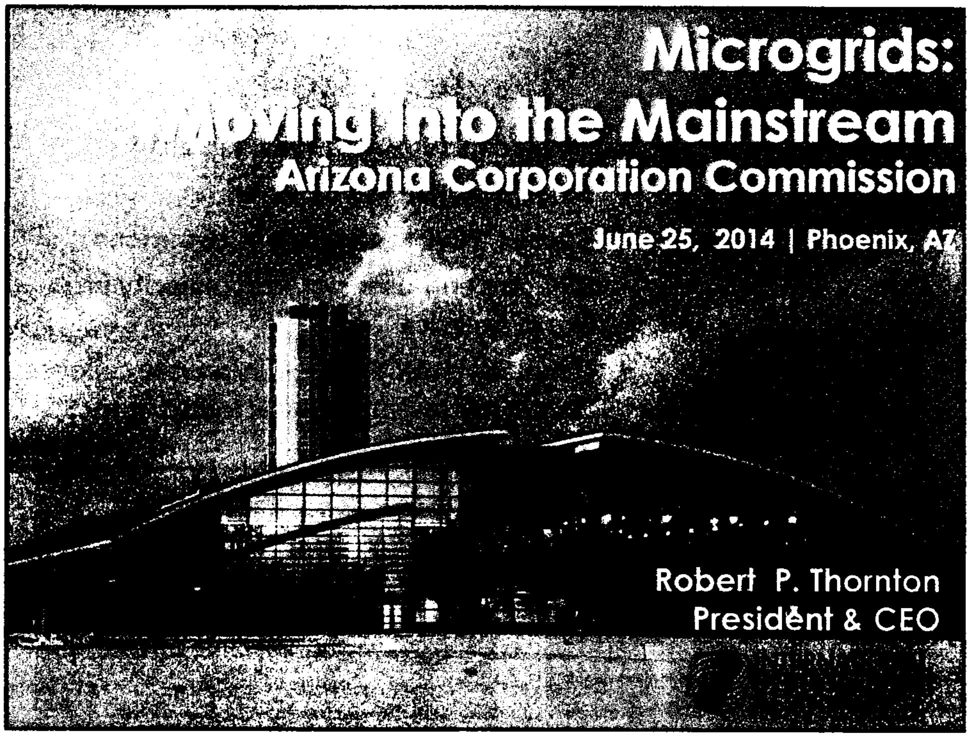
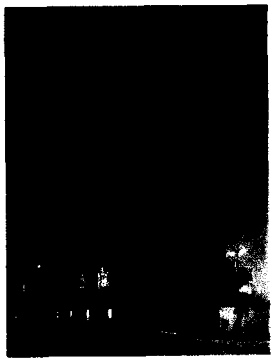


Agenda

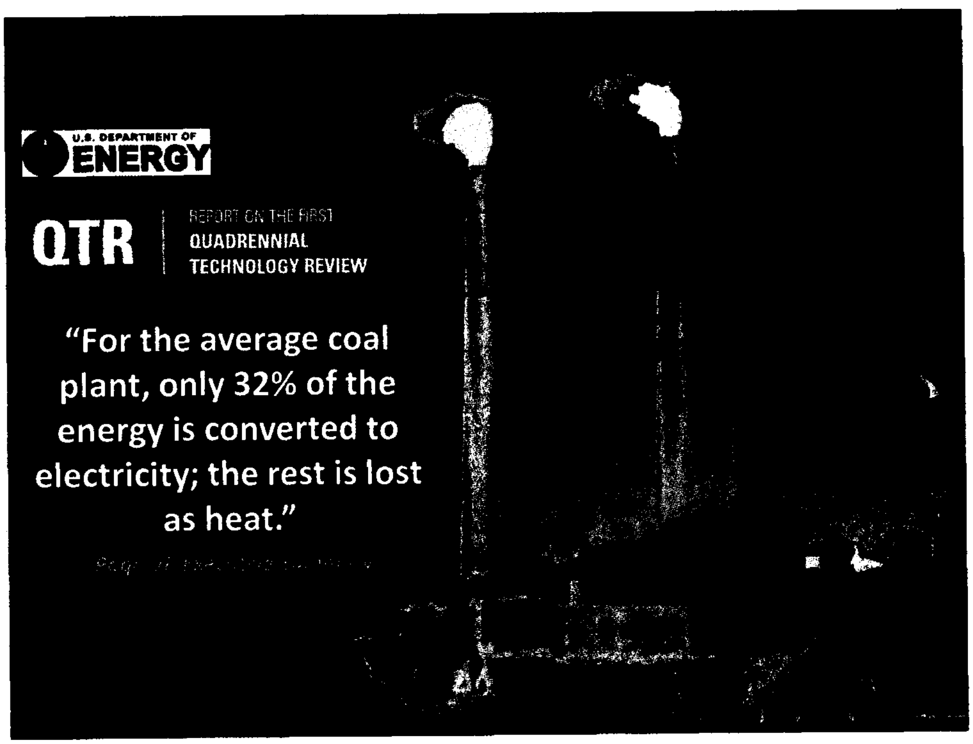
- U.S. Electricity Generation – Shifting Paradigm
- What is a Microgrid? What Are Attributes?
- Case Examples of Operating Microgrids
- Why Build MG's?
- Regulatory and Emerging Policy Issues
- Q&A

INTERNATIONAL DISTRICT ENERGY ASSOCIATION

INTERNATIONAL DISTRICT ENERGY ASSOCIATION



- Formed in 1909 – 105 years in 2014
- 501(c)6 industry association
- Approx. 2000+ members in 26 nations
- 56% are end-user systems; majority in North America
- Downtown utilities; public/private colleges & universities; healthcare; industry, etc.

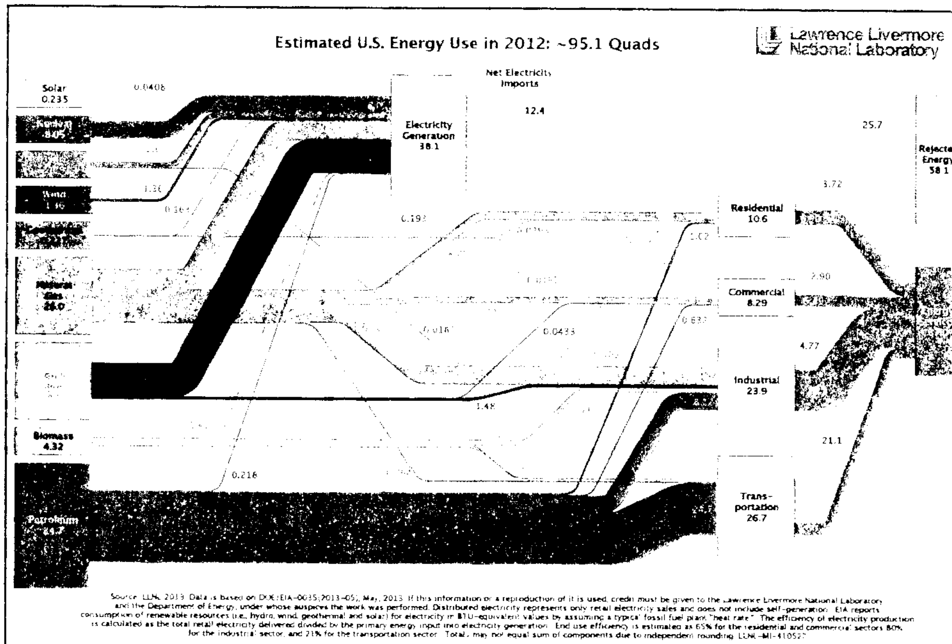


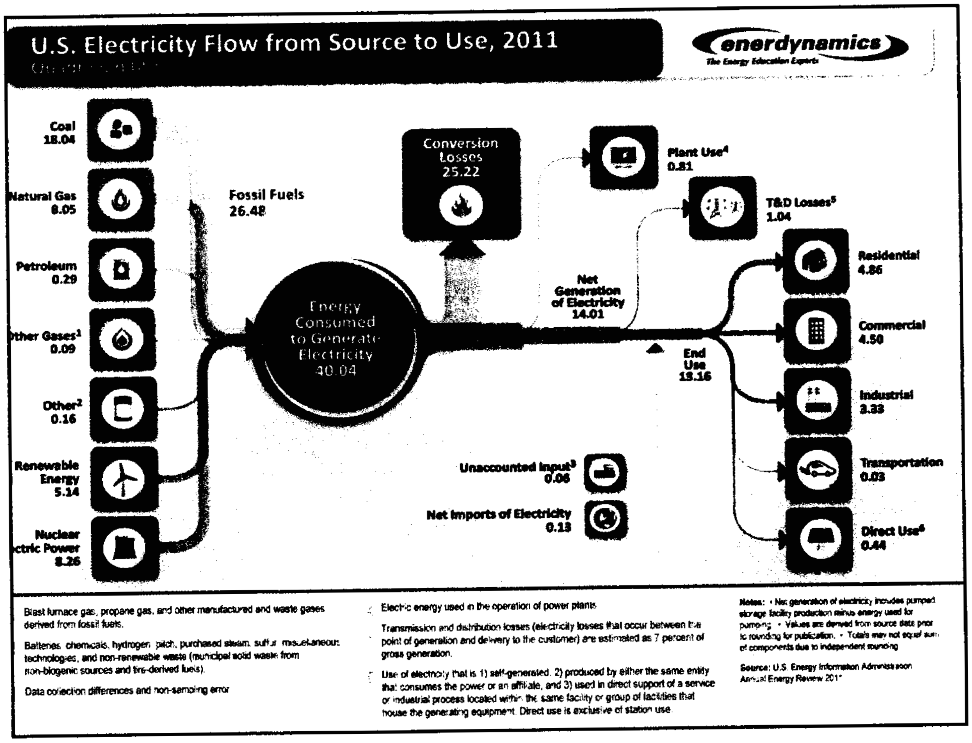
Efficiency of US Power Generation

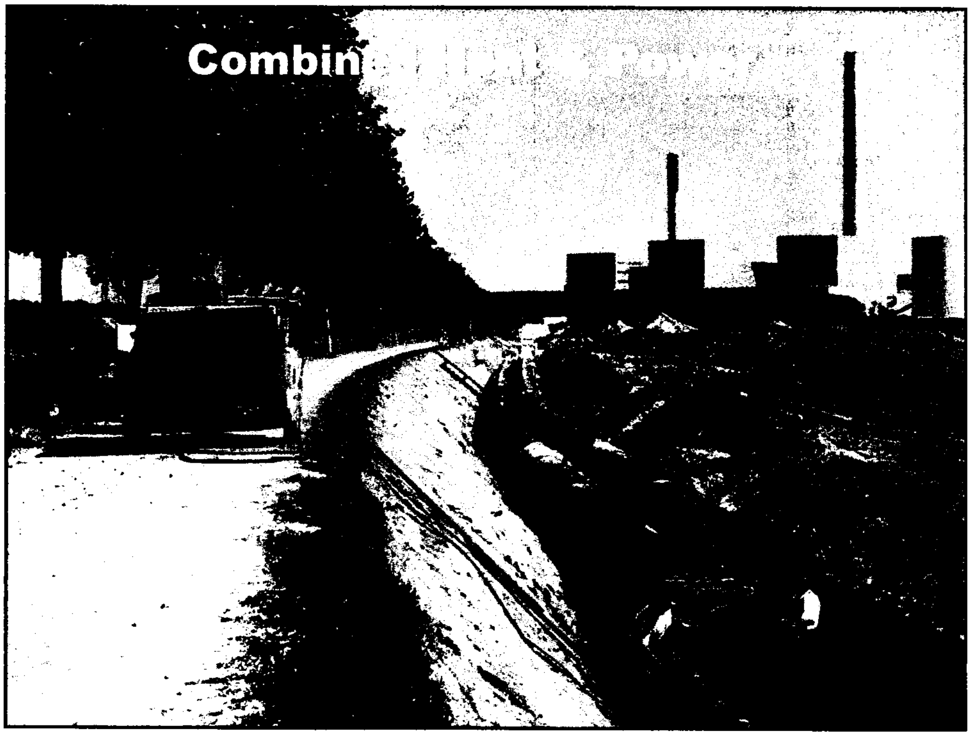
U.S. COAL-FIRED POWER PLANTS RANKED BY EFFICIENCY

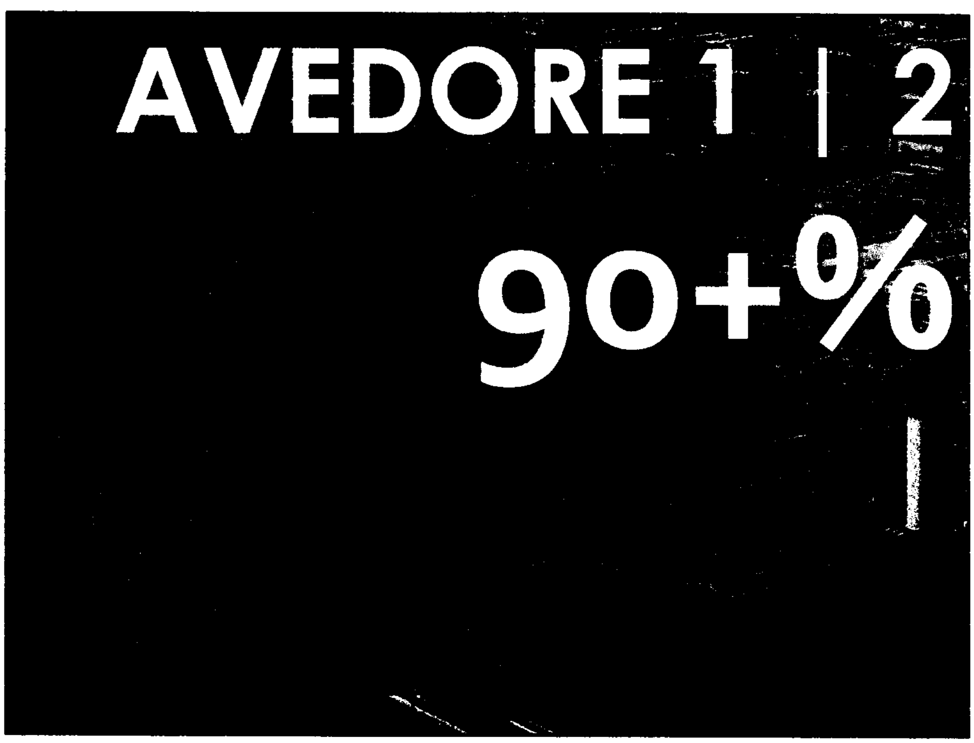
Decile	No. of units	Net nameplate capacity (GW)	Capacity factor	2007 total generation (BkWh)	2007 generation weighted efficiency (HHV)
1	181	30	67%	177	26.5%
2	108	30	70%	180	30.0%
3	90	30	73%	189	31.0%
4	73	30	73%	189	31.7%
5	84	30	75%	194	32.4%
6	75	30	69%	181	33.2%
7	79	29	71%	182	34.0%
8	70	30	70%	186	34.9%
9	57	29	72%	184	35.9%
10	46	30	74%	192	37.9%

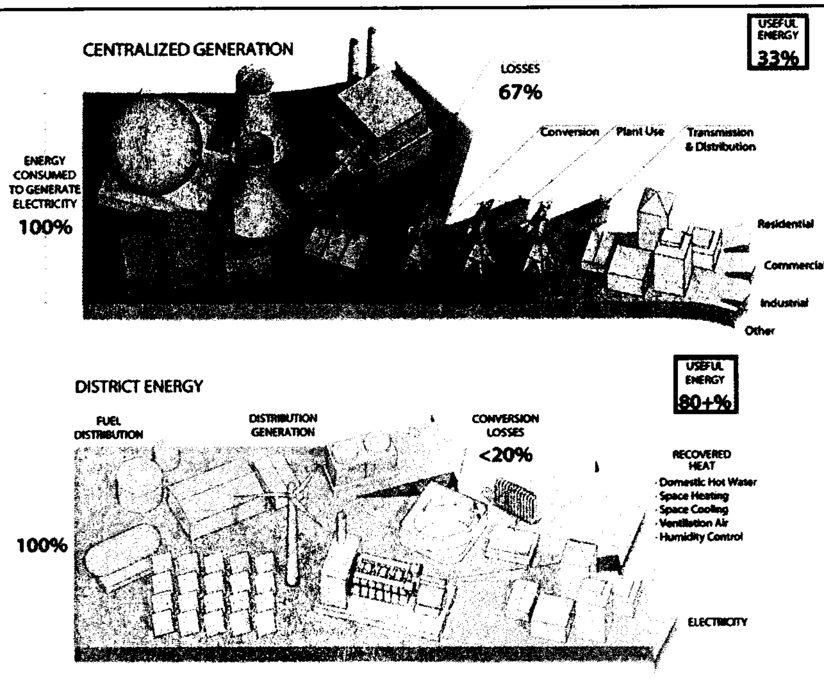
Power Engineering Magazine, November 2009




U.S. Electricity Flow from Source to Use, 2011
enerdynamics
The Energy Education Experts
Coal
18.04
Natural Gas
8.05
Petroleum
0.29
Other Gases¹
0.09
Other²
0.16
Renewable
Energy
5.14
Nuclear
Electric Power
8.26
Fossil Fuels
26.48
Energy
Consumed
to Generate
Electricity
40.04
Conversion
Losses
25.22
Net
Generation
of Electricity
14.01
Plant Use⁴
0.81
T&D Losses⁵
1.04
End
Use
13.16
Residential
4.86
Commercial
4.50
Industrial
3.33
Transportation
0.03
Direct Use⁶
0.44
Unaccounted Input³
0.06
Net Imports of Electricity
0.13


Combin


AVEDORE 1 | 2
90+%



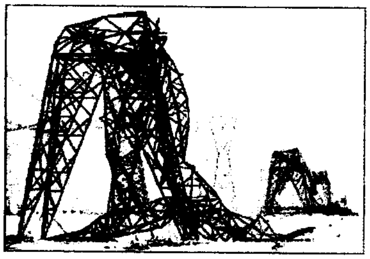
Illustration, copyright AEI / Affiliated Engineers, Inc.

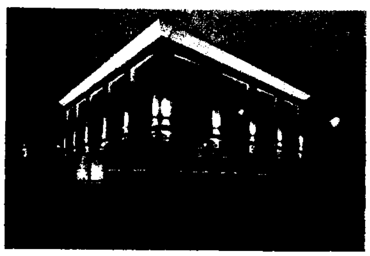
Paradigm Shift

In U.S., during the first half of 2012:

- 165 new electric power generators installed
- Totaling 8,100 megawatts (MW) new capacity
- Of 165, 105 of those units under 25 MW and
- Mostly renewable - solar, wind or landfill gas
- Other factors - environmental compliance costs; poor load factor; low wholesale power costs and cheap natural gas

District Energy/CHP/Microgrid Emerging Drivers



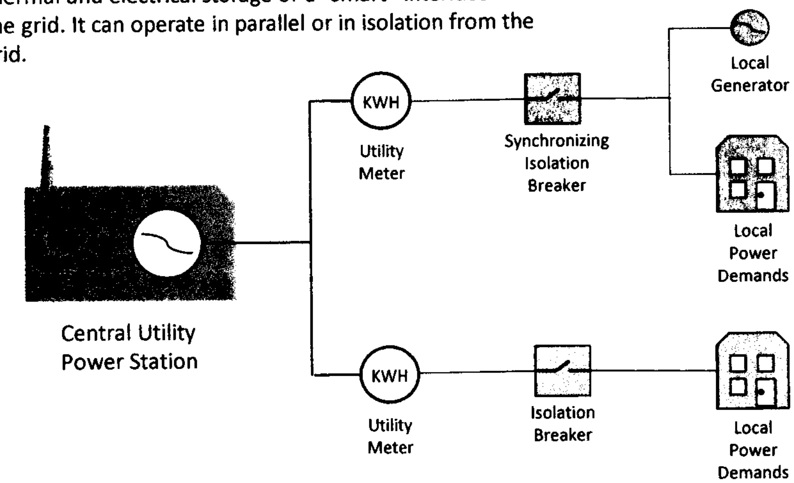


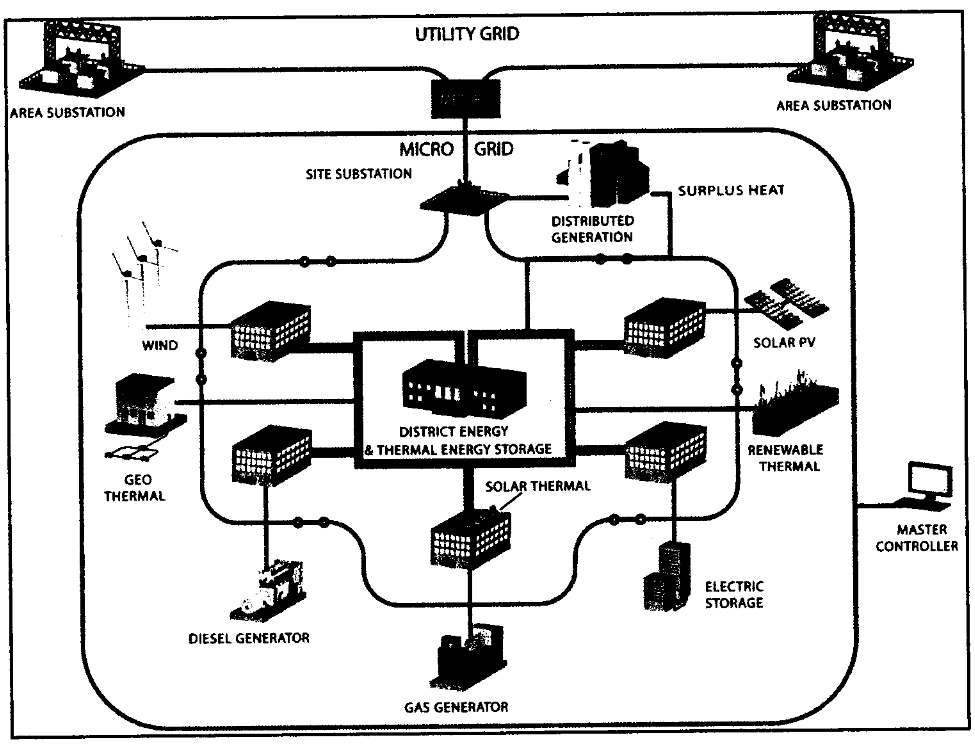
- Growing demand for greater grid reliability and resiliency
- Choice to deploy clean energy sources to help compete for high quality employers, factories, tenants
- Desire to expand local tax base & replace remote coal generation
- Flexibility to tap local energy supplies to improve trade balance & drive economic multiplier
- Cutting GHG emissions and addressing climate adaptation
- Local infrastructure advantages in extreme weather events

MICROGRIDS: LOCAL, RESILIENT AND CLEAN ENERGY INFRASTRUCTURE

What is a Microgrid?

A local electrical system that combines retail load and distributed generation. A microgrid may include integrated management of thermal and electrical load, thermal and electrical storage or a "smart" interface with the grid. It can operate in parallel or in isolation from the grid.





What Utilities Provide The Grid:

THE OBVIOUS:

- Energy – KWHs
- Infrastructure to deliver energy

ALSO:

- Diversity of fuel sources
- Diversity of generating locations
- Capacity, planned for peak loads
- Redundancy in case of failures
- Diverse power delivery network
- Voltage stability
- Frequency stability
- Wave form stability
- Metering & billing

Microgrid Resources Can Provide:

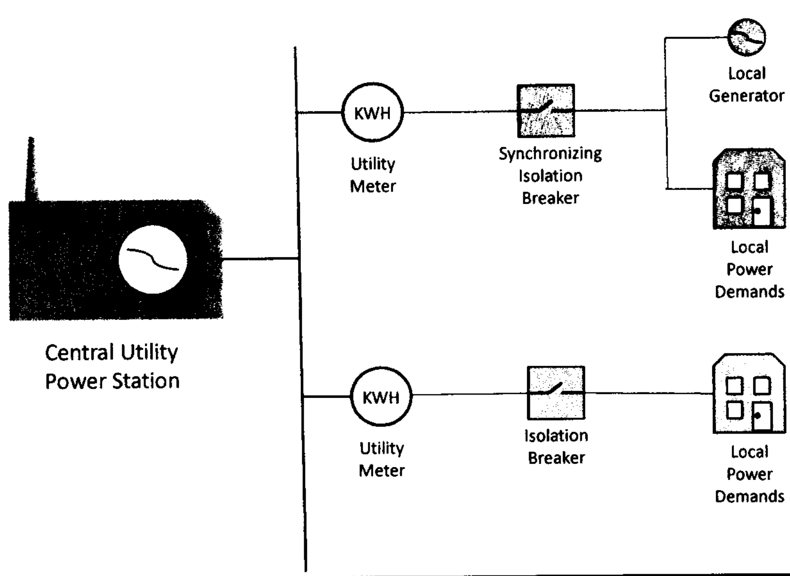
THE OBVIOUS:

- Energy – KWHs
  - High efficiency and lower environmental impact due to CHP
  - Reduced congestion with proximity to actual loads
- More control over **demand & load shape**
  - Integrate thermal resources (+ storage) to offset expensive peak loads for heating/cooling
  - Use more base-load plants, avoid peaking plants
  - Reduce costs for all customers

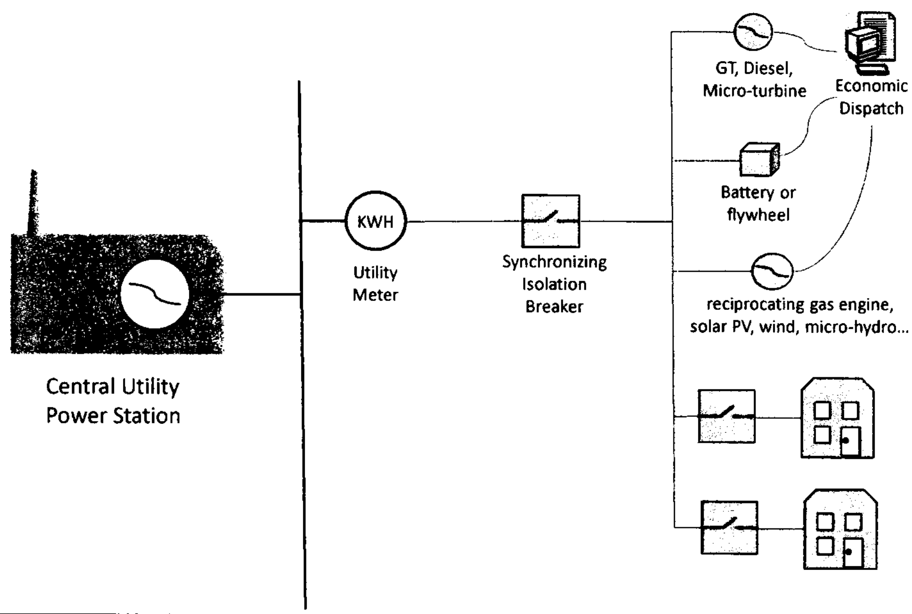
Microgrid Resources Also Provide

- Diversity of generating locations
  - Reduced risk associated with transmission and distribution failures
- Diversity of fuel sources
- Capacity, planned for ***local, critical*** loads
- Thermal energy for district heating, cooling
- Redundancy in case of grid failures
  - Small, localized failures instead of regional failures
- Voltage stability
- Frequency stability
- Wave form stability

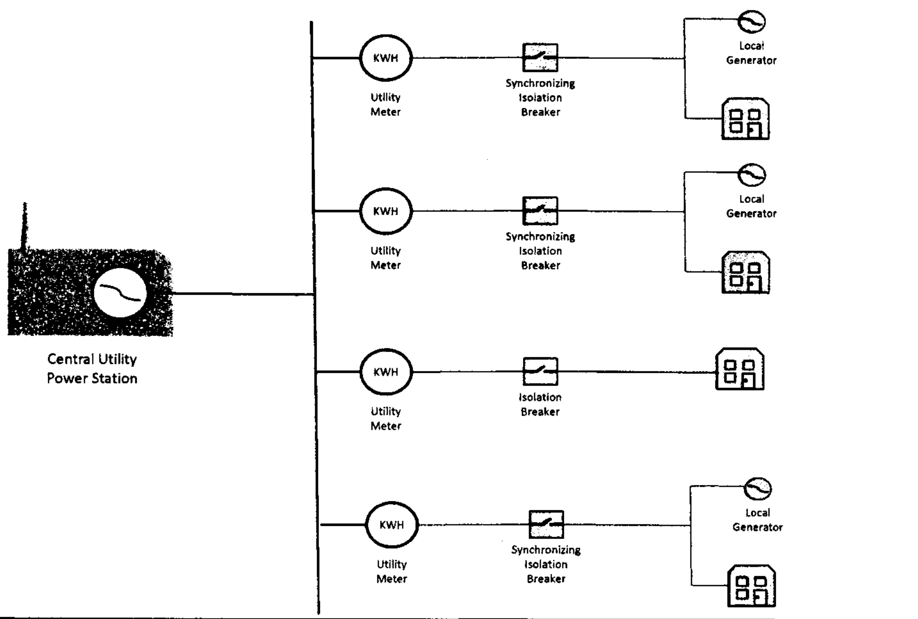
Simple Microgrid Concept



Microgrid Options



Microgrids Add Grid Reliability



Why Build A Microgrid?

- Benefits for the Owner
  - Enhanced Reliability and Resiliency
  - Cost Reduction
  - Environmental
- Benefits for the ISO
  - Reduction in LMP Cost
  - Increase Capacity Supply
  - Reduction in Transmission Needs
  - Reduction in Marginal Losses
  - Rapid Frequency Regulation
  - Spinning Reserve

Why Build A Microgrid?

- Benefits to the Local Economy
  - Enhanced Reliability/Resiliency – Reduce business interruption risk
  - Areas of Refuge for Citizens/First Responder Support
  - Power for Local Critical Infrastructure
    - Hospitals, Gas Stations, Police & Fire, Waste Water Treatment Plants
- Benefits to Local Electric Distribution Utility
  - Reduced Peak Load
- Problems for Local Electric Distribution Utility
  - Loss of Revenue
  - Interconnection Issues

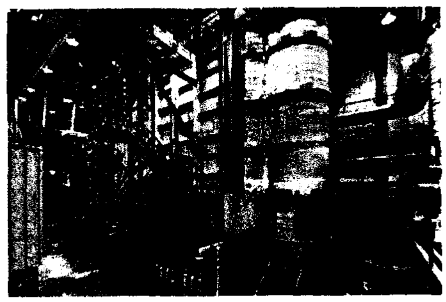
Multi-Building Microgrids

- Microgrids not recognized as a unique class of grid resources
- They are under-utilized and under-compensated for
  - Providing energy and auxiliary services
  - Contributing to reliability and availability
  - Ability to quickly balance intermittent renewables
- They face state regulatory hurdles including:
  - Limits on servicing multiple customers
  - Limits on serving multiple properties of the same customer
  - Limits on partnering with third party developers
- The current utility business model provides disincentives to customer efficiency and flexibility
- Currently, MUSH market represents "best in class"

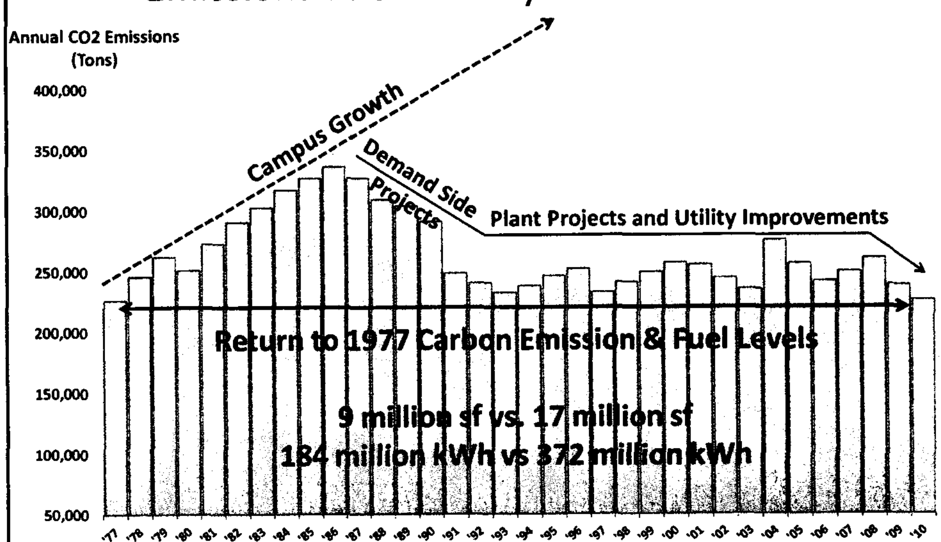
MICROGRIDS: ENHANCED EFFICIENCY

University of Texas at Austin

- Began Microgrid operations in 1928 – 100% of power load
- 17 Million SF; 150+ buildings; 71,000 population
- 143 MW CHP, 325k lb/hr peak steam; 44,000 tons CHW
- 99.9998% availability over 35+ years
- Invested $150M in energy efficiency since 1987
- Cut CO^2 emissions by > 90,000 tons/year

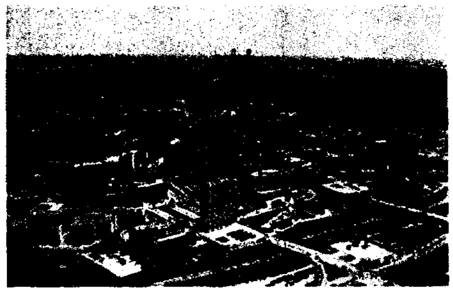


Effects of Utility Improvements on Efficiency and Emissions at University of Texas Austin



Thermal Energy Corporation (TECO)

- Serves the Texas Medical Center – largest medical center in the world
- 18.9 million square feet
- 18 institutions, all are not-for profit
  - 7 hospitals
  - 2 medical schools
  - 3 nursing schools
- 6,800 hospital beds
- "Mission-critical" customer base
- $1.2 billon of annually funded medical research



Thermal Energy Corporation (TECO)

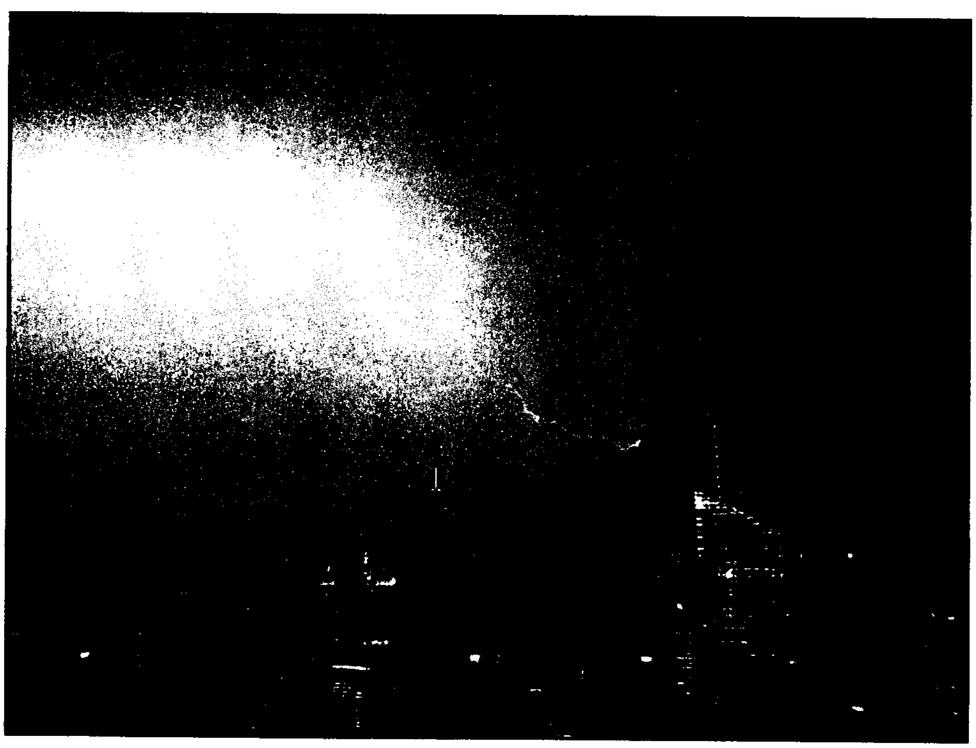
- District heating/cooling since 1969
- Added 48 MW natural-gas CHP in 2010
- System efficiency now +80%
- Cut 302,000 tons of CO^2/yr
  - Removing 52,000 cars
  - Planting 83,000 acres
- Avoided $3000 per MW peak power charges summer 2011
- Returned over $9 million in operating expense savings to customers FY 2011

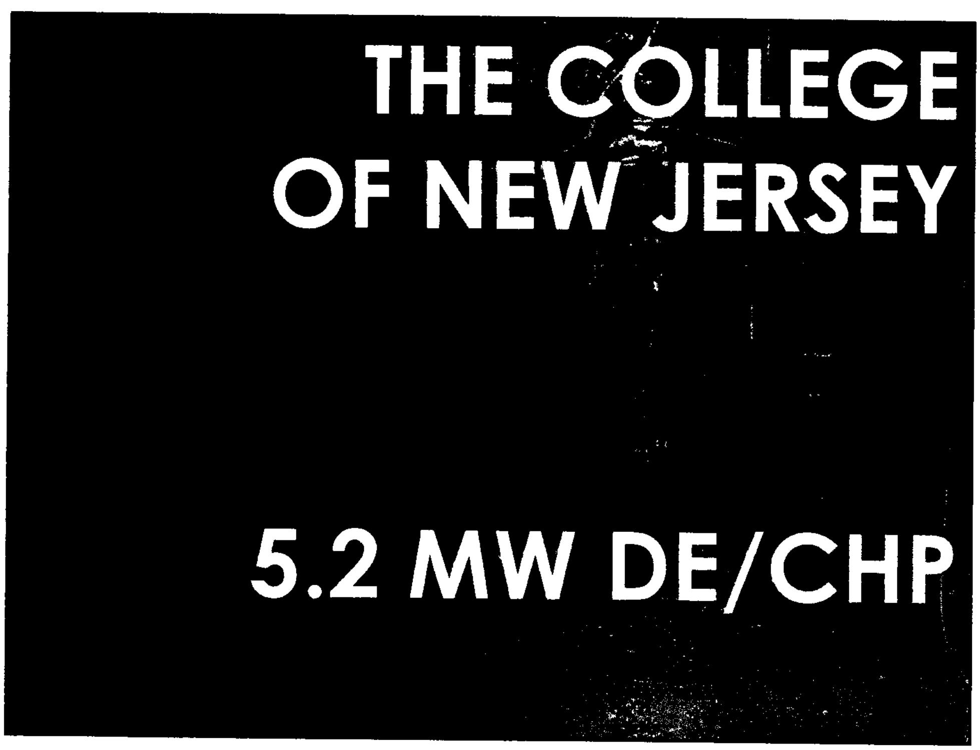
MICROGRIDS: ENHANCED RESILIENCY

8,100,000 homes lost power

57,000 utility workers from 30 states & Canada assisted Con Edison in restoring power

Total estimated cost to date $71 billion+ (dni lost business)




THE COLLEGE
OF NEW JERSEY
5.2 MW DE/CHP

"Combined heat and power allowed our central plant to operate in island mode without compromising our power supply."

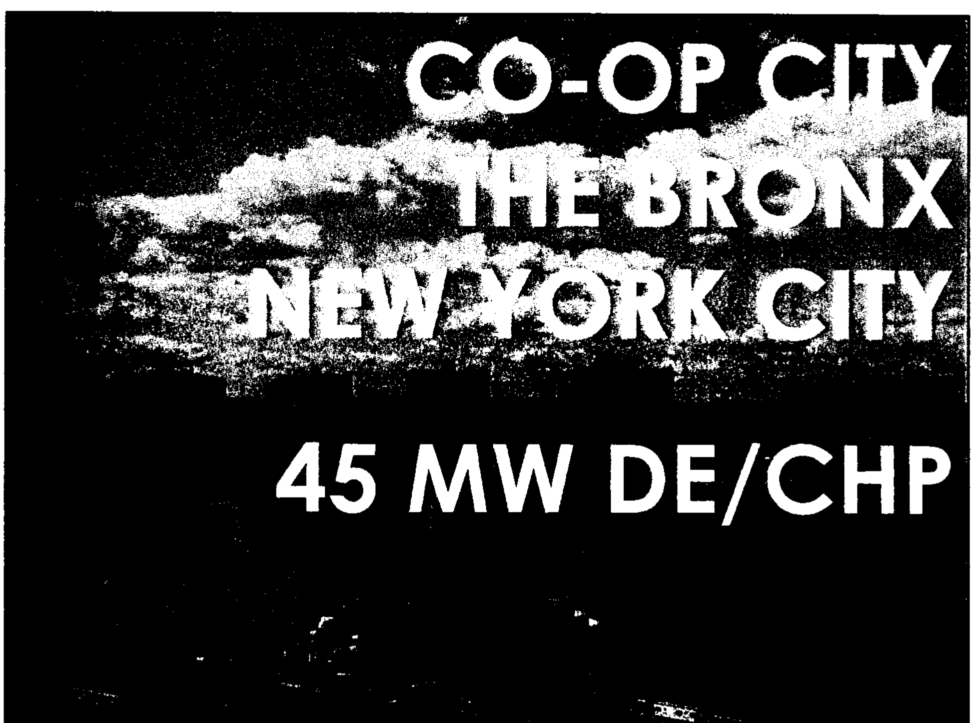
Lori Winyard, Director, Energy and Central Facilities at TCNJ

FAIRFIELD UNIVERSITY CONNETICUT

4.6 MW DE/CHP

98% of the Town of Fairfield lost power, university only lost power for a brief period at storm's peak

University buildings served as "area of refuge" for off-campus students



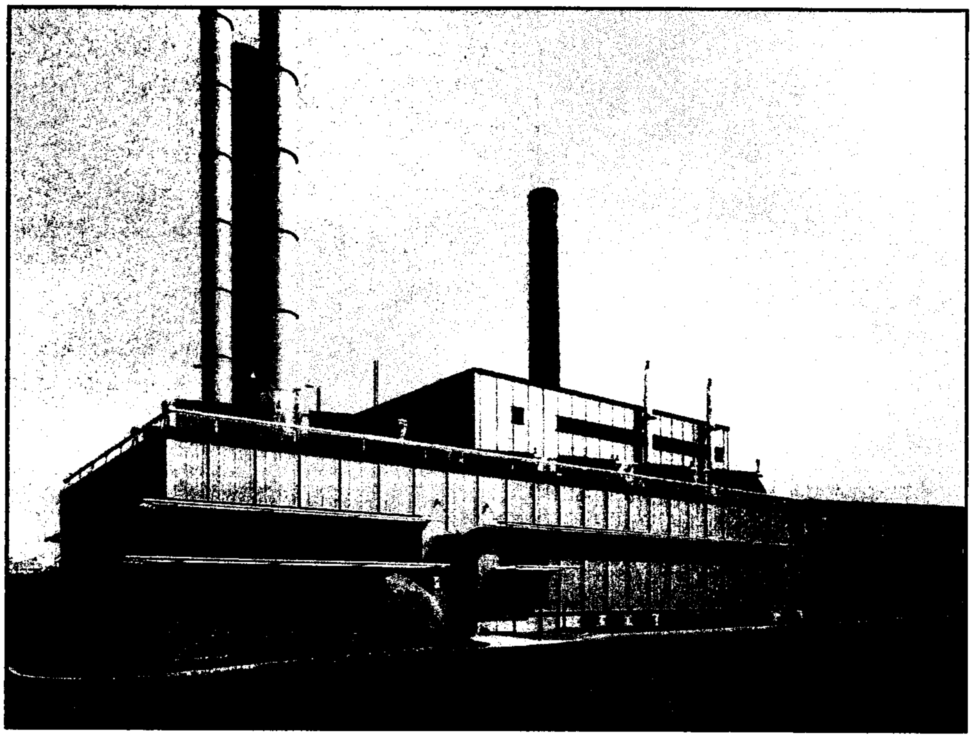
"City within a city"

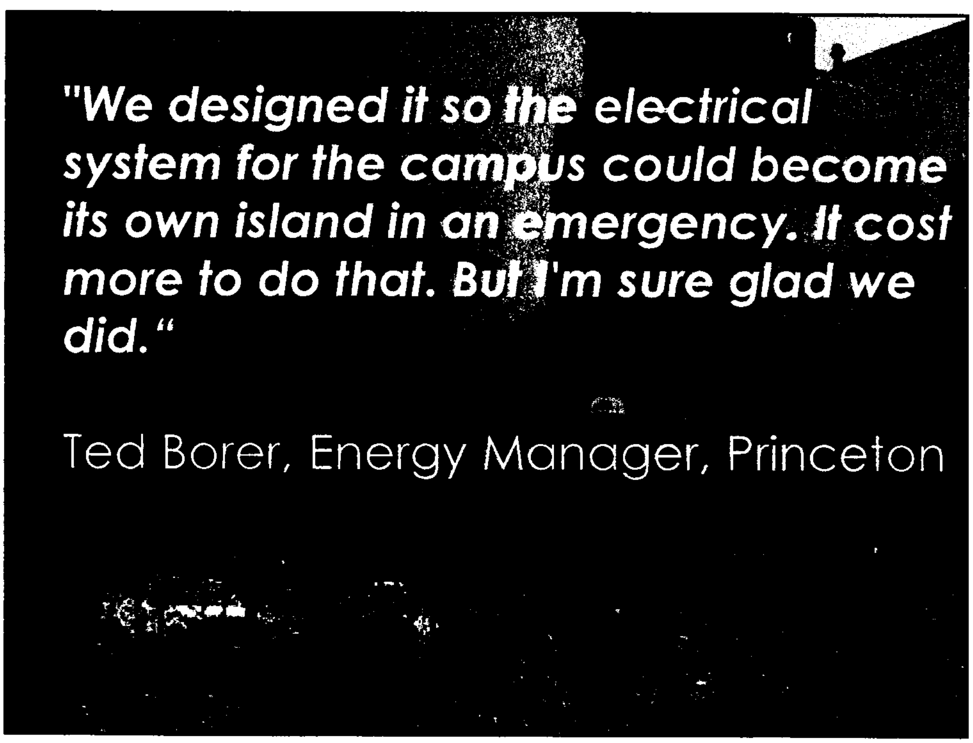
60,000 residents, [illegible] acres, 14,000+ apartments, 35 high rise buildings

One of the largest housing cooperatives in the world; 10th largest "city" in New York State

40 MW Cogen plant maintained heat and power throughout Sandy – back fed Con Edison grid

PRINCETON UNIVERSITY
15 MW District Energy CHP
STORM-TESTED
+PROVEN ANNUALLY



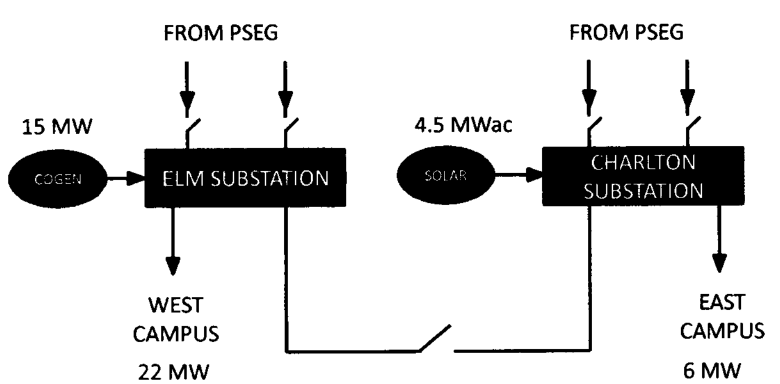

"We designed it so the electrical system for the campus could become its own island in an emergency. It cost more to do that. But I'm sure glad we did."
Ted Borer, Energy Manager, Princeton

October 2011
Hurricane Irene

October 2012
Hurricane Sandy

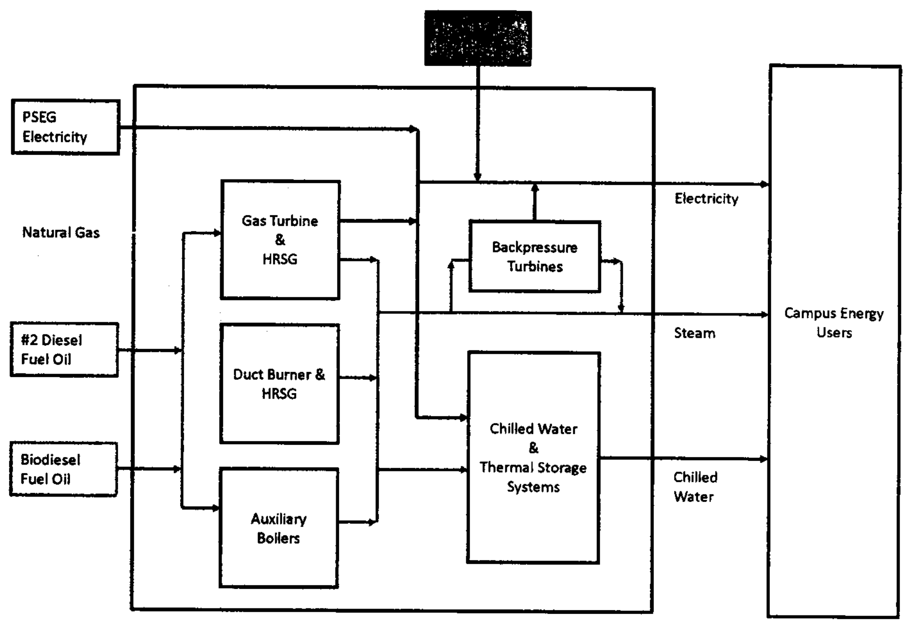
Lights. Stayed. On.

Princeton University's Microgrids

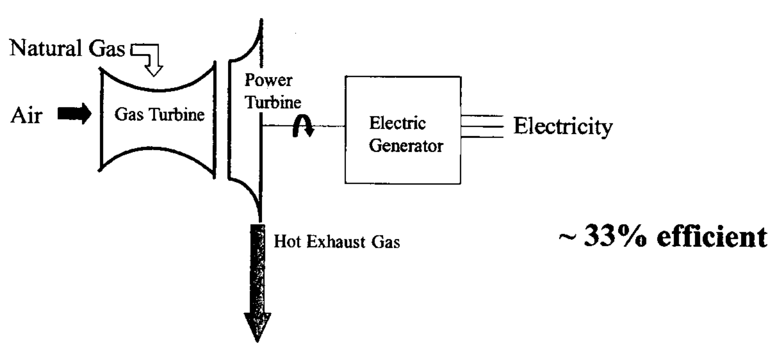


Facilities
Engineering

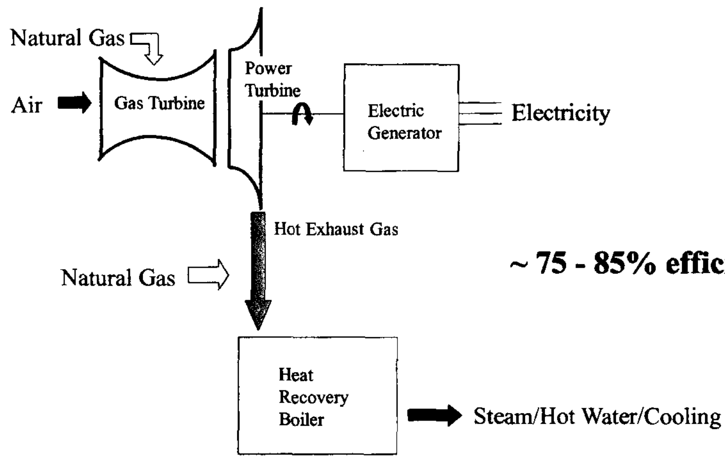
Princeton Plant Energy Flows



Conventional Power Generation

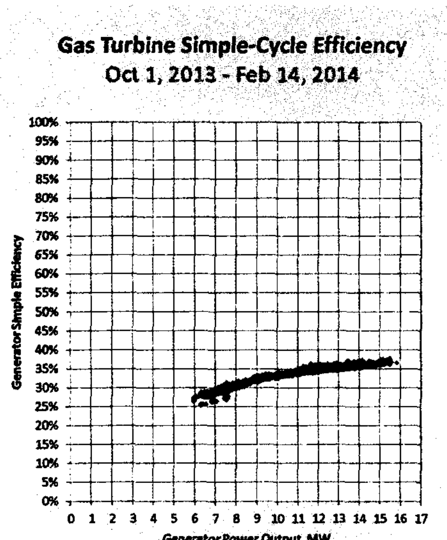


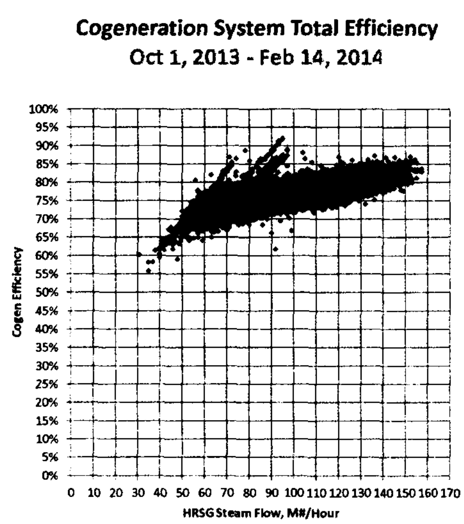
District Energy/CHP/Microgrid



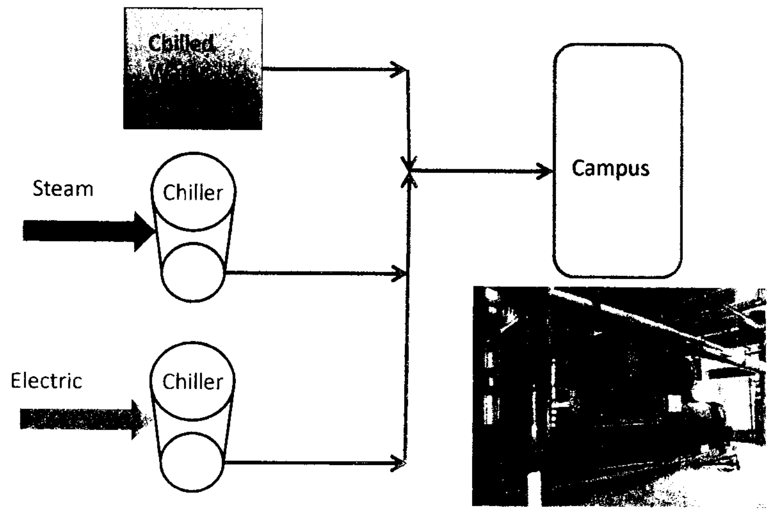
~ 75 - 85% efficient

How Much More Efficient is Combined Heat & Power?

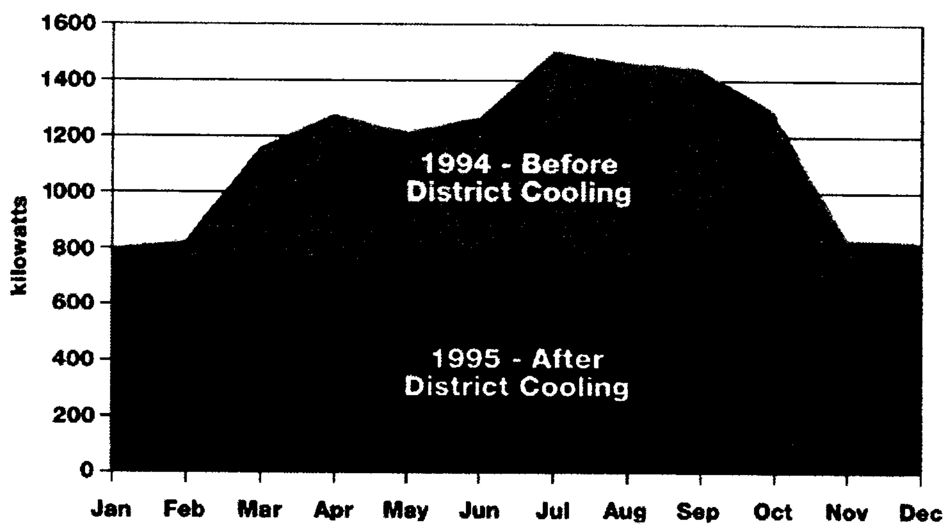




Chilled Water Plant

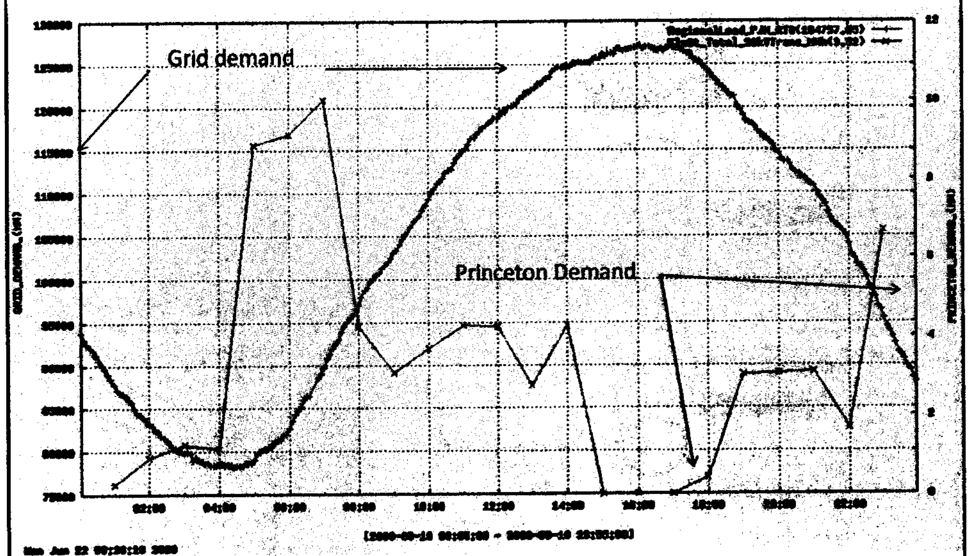


Facilities
Engineering

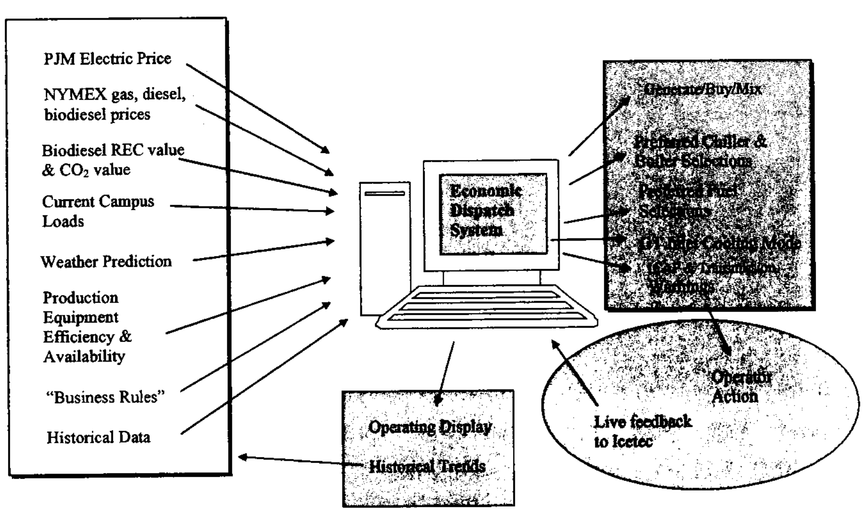


350,000 sf commercial office building built in 1965. Located in Cleveland. Two electric chillers displaced. Actual peak meter readings varied just 2% Jan-July.

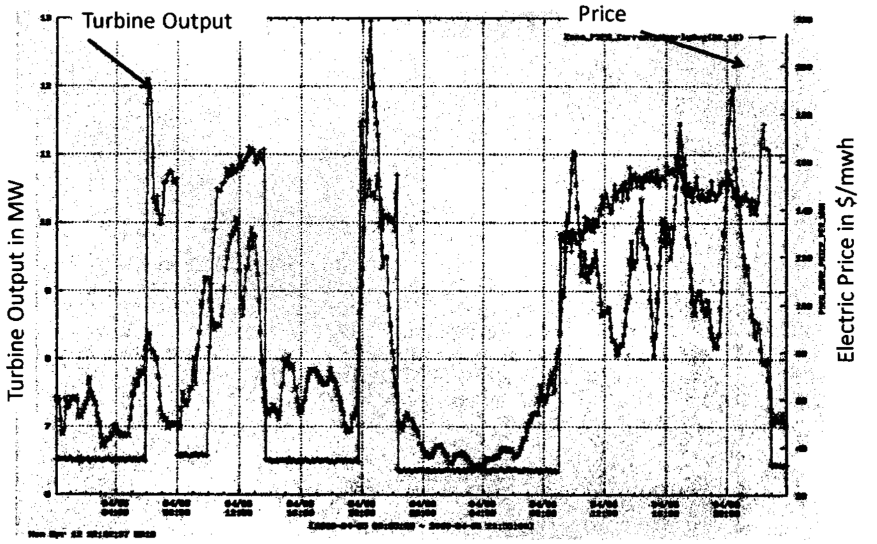
Princeton CHP/District Cooling Reduces Peak Demand on Local Grid



Economic Dispatch System



Princeton Micro-Grid Power Generation Dispatch To Optimize Savings – PJM Grid

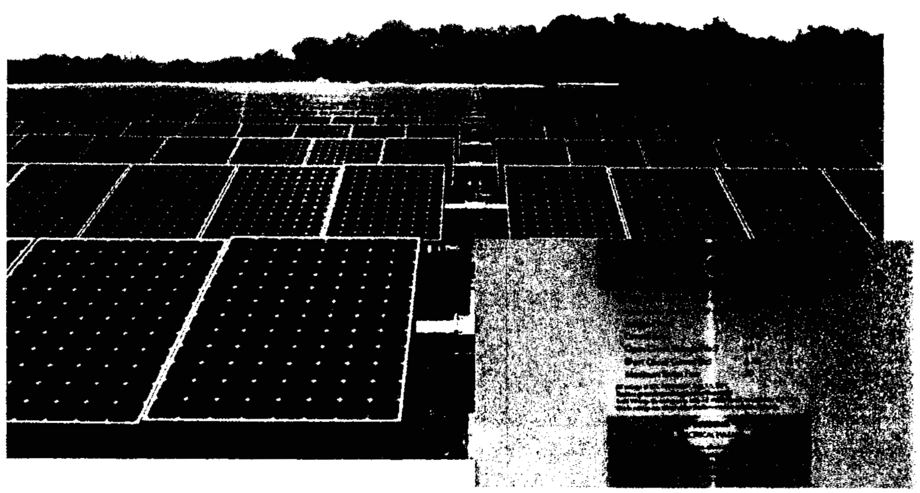


$1.0 to 3.5 Million per year

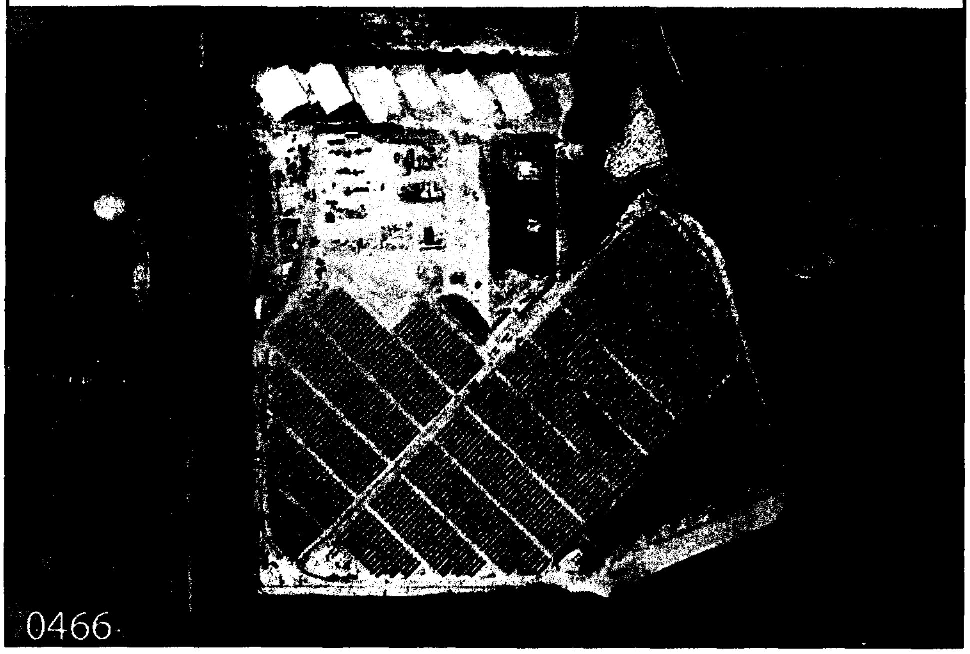
Facilities Engineering

Princeton University PV Farm – Aug, 2012

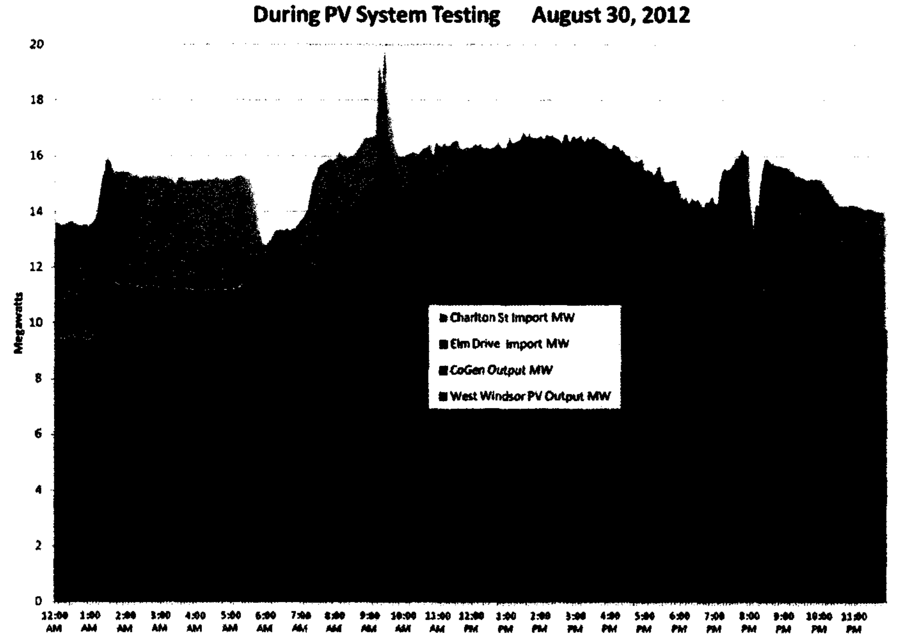
16,500 PV panels generate up to 327 Watts each at 54.7 Volts DC

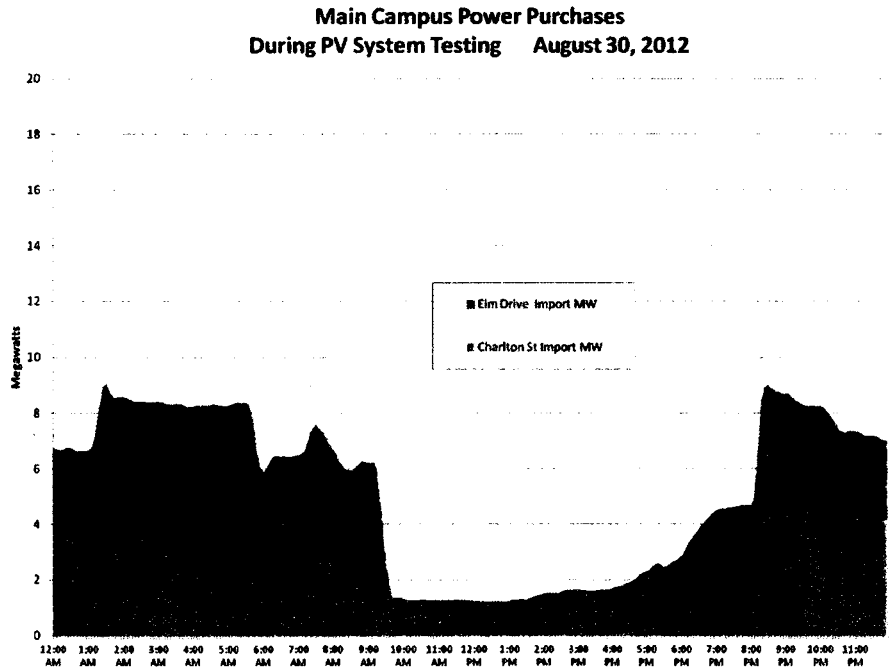


Princeton University 5.4 MW Solar Farm



Main Campus Power, Generated & Purchased
During PV System Testing August 30, 2012





Princeton University Microgrid Benefit to Local Grid

During August peak: 100$^+$ deg F; 80% RH

- 2005 campus peak demand on grid 27 MW
- Implemented advance control scheme
- 2006 campus peak demand on grid 2 MW
- Microgrid “freed up” 25 MW to local grid
  - reduces peak load on local wires
  - avoids brownouts
  - enhances reliability
  - supports local economy

MICROGRIDS: ATTRIBUTES / BENEFITS

Microgrid Attributes/Benefits

- A microgrid is a local electric system or combined electric and thermal system that includes retail load and the ability to provide energy and energy management services needed to meet a significant proportion of the included load on a non-emergency basis;
- is capable of operating either in parallel or in isolation from the electrical grid, and that,
- when operating in parallel, may be capable of providing energy, capacity, ancillary or related services to the grid.

Microgrid Attributes/Benefits

- Using CHP to serve balanced electric and thermal loads, microgrids can achieve generation efficiencies above 80 % compared to 32 to 45 % for conventional generation
- By using thermal and electrical storage to manage time of use of imported electricity and fuel, microgrids help moderate power prices by efficiently shifting load to times of lower demand and pricing.
- Including renewable energy allows microgrids to undertake efficient and flexible hybrid generation operations
- These energy management strategies not only save money but also significantly reduce the environmental impact of providing energy services.

Microgrid Attributes/Benefits

- By **"islanding"** from the grid in emergencies, a microgrid can both continue serving its included load when the grid is down and serve its surrounding community by providing a platform to **support critical services** from hosting first responders and governmental functions to providing key services and emergency shelter.
- Microgrids can make it feasible to place generating capacity in **congested areas** of the grid closer to load density and, from a planning perspective, can reduce contingencies that threaten grid stability.
- Through fine tuning its own generation and load, a microgrid can **provide load following** and other ancillary services to the grid in response to real time signals.
- Moreover, they are capable of providing energy and **multiple ancillary services** at the same time. Local microgrid service providers can make the **operation of the grid more competitive.**

Microgrid Business Best Practices

- Fully integrated load monitoring, forecasting, operational flexibility, responsiveness
- Parallel operation with real time price signals and optimization strategies (make/buy)
- Ancillary services – capacity, frequency and demand reduction
- Bankable business models will be critical for risk averse customers

MICROGRIDS: POLICY ISSUES

Industry Policy Aims

- Improve overall efficiency & reliability of regional and local grid
- Define microgrids and their services accurately in state regulatory schemes
- Outline fair compensation for value produced
- Help reinvent reliability planning to take full advantage of microgrid services
- Accelerate deployment of microgrids
- Help define grid business models of the future

Microgrid Policy Opportunities

- Help to transition state policies from ignoring energy waste to rewarding generation efficiency
- Fairly address market access restrictions; rights of way; interconnection; departing load charges
- Strengthen grid and reduce regional emissions
- Achieve proper valuation of costs of lost business and interruption risks ($21 M in NJ in 2012)
- Not just an electricity issue; nor just supply
- Private capital may seek multiple energy revenue streams to address risk/achieve returns
  - Microgrids may not be competitive with power only

Barriers to Implementation

• Microgrids face **often-conflicting regulation** at the federal, state and sometime local levels.

• As FERC has recognized, even though they are generally located **behind the meter** on the distribution system, microgrids provide services that **substitute for and compete with** the services of wholesale generation.

• They generally **purchase power at retail rates**, either from utilities or, where allowed, competitive load serving entities that are regulated by state public utility commissions (PUCs), and they **sell power at wholesale rates** subject to FERC jurisdiction.

• Adoption by Independent System Operators (ISOs) and RTOs is following slowly, there is still much room for improvement.

• **Regulations** are designed for resources that are **generators or provide load curtailment,** not resources that are both.

• Microgrids employing multiple energy management technologies can **simultaneously provide multiple services** with multiple set points, but market rules generally do not permit them to do so. Traditional baseline load calculations for demand resources do **not capture the optionality** of microgrids.

• In addition, microgrids are generally **not recognized as capacity** resources.

Barriers to Implementation

- **"Congestion pricing"** in RTO markets allocates the use of the system but does not provide an incentive to site generation to meet grid planning goals.
- Microgrids are **neither transmission nor pure generation** and are really not contemplated by the planning system at all, even though they can provide reliability and economic benefits to the grid.
- In some states it is not possible for an independent developer **to provide energy generation services** to a single customer on the customer's own site, and in most states it is not possible to aggregate retail load from multiple customers into a microgrid.
- Even in states with retail deregulation, load serving entities generally must **provide energy on an all or nothing basis**. Community choice aggregation legislation, virtual net metering, and, in a few states, specific microgrid support legislation, are the exceptions.
- As a result, most sophisticated microgrid development has **occurred on campuses, universities or private research facilities**, where a single end user is microgrid host. Even interconnecting multiple facilities of a single user across roads or intervening properties can contravene state law in some states.

Barriers to Implementation

- Utility companies are **compensated** on basis of the **total megawatt-hours (MWh) delivered**, and a reduction in retail demand through energy efficiency or distributed generation **threatens business model**.
- Generally, utility rate **regulation discourages** distribution companies and integrated utilities from encouraging microgrid development.
- Distribution networks play a **critical role in supporting** customer microgrids and eventually can contribute to integration of multiple microgrids into more self-healing, resilient regional electric systems.
- Non-discriminatory compensation for all services provided to and by microgrids, and support investment incentives for **linking microgrids into the grid of the future.**
- Without new business models that reward distributed energy resources while also maintaining the financial viability of the distribution system, the promise of microgrids will not be achieved.

Industry Regulatory Objectives

- Define the microgrid resource in the context of each regulatory scheme to **seek parity for resources** with similar capabilities and non-discriminatory treatment where microgrids can provide exceptional performance.
- Identify all the layers of **services being provided <u>to</u> and provided <u>by</u>** microgrids including energy market and ancillary services, locational capacity, transmission distribution and related reliability services, and local and regional resiliency services.
- Establish the basis for **reasonable tariffs** than do not discriminate between wires and generation and among end users, distribution companies and independent developers to the extent that they provide equivalent reliability and adequacy services.
- Seek ways to **implement and incentivize integrated reliability planning** that accommodates the interests of private sector and regulated infrastructure investors, state and federal regulators, and stakeholders.
- **Support local governments** in their efforts to achieve more resilient and cost –effective energy infrastructure and join the conversation to define the utility business model of the future.

Microgrid Industry Objectives

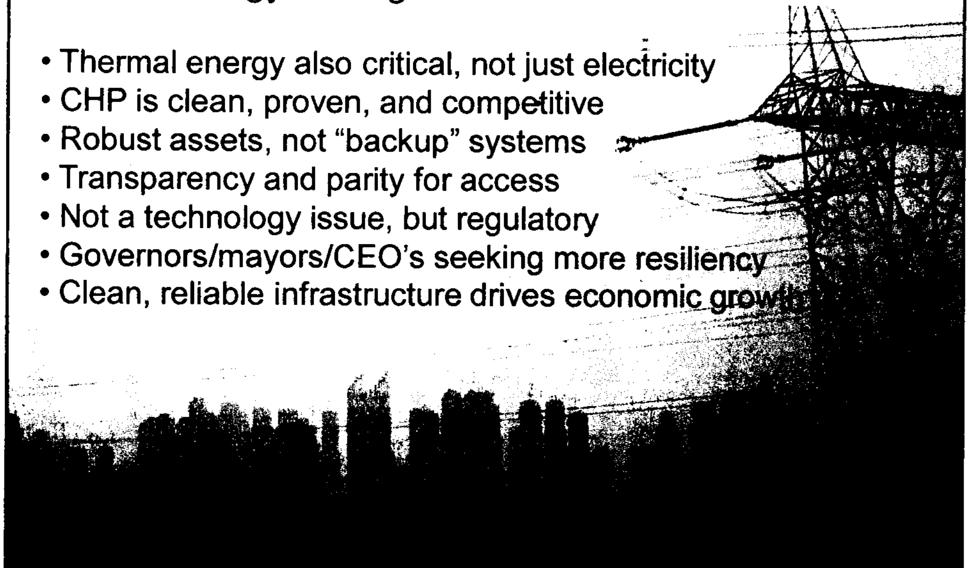
1. Equitable access to grid resources and revenue
2. A new grid paradigm with more owners of distributed resources on the grid
3. Economic fairness and transparency for all grid participants; reasonable cost for access
4. Durable and predictable regulations to de-risk investments and attract private capital

State Policy Drivers - Choice

- **Massachusetts** - Green Communities Act, 2008
  - Provides for Alternative Energy Portfolio (APS)
  - S.2395 (2012) calls for the study of alternative energy that provides"useful thermal energy"
  - DPU-12-76 – MA Grid Modernization Act, July 2013 – compelling investment in microgrids
- **New Jersey**: New Jersey BPU - P.L.1999, c.23, and P.L.1997, c.162
  - Cogeneration Law (2009) enables retail wheeling of cogenerated electricity to thermally-connected customer buildings
- **New York:** "Reforming the Energy Vision" – NYS DPS, May 4, 2014
  - Provides for more distributed generation, microgrids and DSPP's
- **Connecticut**: CT DEEP, Public Act 12-148 Microgrid Grant & Loan Pilot Program
  - Clean Energy Finance and Investment Authority and Energy Improvement Districts (EIDs) – allows interconnect to public buildings for resiliency
- **Maryland:** "Resiliency Through Microgrids Task Force", Feb 2014
  - Study the statutory, regulatory, financial, and technical barriers to the deployment of microgrids in Maryland.

District Energy/Microgrids: Final Considerations

- Thermal energy also critical, not just electricity
- CHP is clean, proven, and competitive
- Robust assets, not "backup" systems
- Transparency and parity for access
- Not a technology issue, but regulatory
- Governors/mayors/CEO's seeking more resiliency
- Clean, reliable infrastructure drives economic growth



INTERNATIONAL DISTRICT ENERGY ASSOCIATION

Thank you for your attention.

INTERNATIONAL DISTRICT ENERGY ASSOCIATION

www.districtenergy.org

Rob Thornton

rob.idea@districtenergy.org

+1-508-366-9339

Other Resources

- www.ThinkMicrogrid.com
- Microgrid Resources Coalition (MRC)
  - www.microgridresources.com

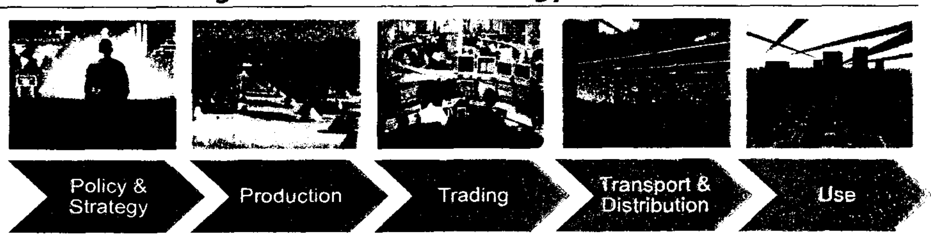
DNV·GL

ENERGY

Sustainable Energy Use Technology

Arizona Corporation Commission Workshop

DNV GL: Serving the Needs of the Energy Value Chain



- Foundation with 16,000+ employees worldwide, 150 year heritage
- Business and technical advisory, operational services, risk management
- Testing, inspections, certification, verification
  - Leadership in standards development
- Research & innovation – at least 5% of annual revenue spent on R&D
- Leader in planning, implementation, and evaluation of sustainable energy use programs

Energy Management Technology Taxonomy

Energy Efficiency Equipment
- Lighting, Appliances, Air Conditioning
- Motors, Refrigeration, Pumps

Building Shell
- Insulation, Windows, Integrated Design
- Infiltration, Building Materials, Shading

Controls
- On-off Timers and Sensors, Variable
- Central, Integrated Management

Information & Analysis Systems
- Monitoring, Logging, Benchmarking
- Energy Assessment, Alarms, Dashboards

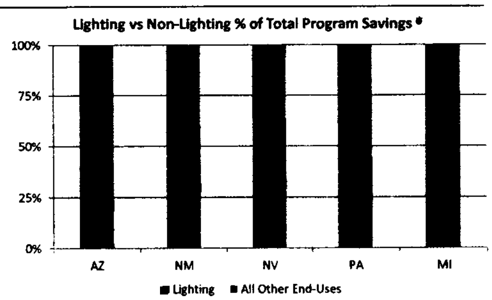
System & Process Optimization
- Commissioning, Maintenance, Heat Recovery
- Process Design, Passive Ventilation

Energy Efficient Equipment: Lighting

Most significant, if not the majority, of total savings for many utility EE programs

Mainstays (but on the decline):
- T5/T8 Linear Fluorescents
- CFL's

What's Next:
- LED Lighting
- Lighting Controls



LED A-Line Lamps LED Recessed Fixtures & Panels LEDs with 'Purpose' - Street Lights, Traffic Signals, and Exit Signs

* *Data from DNV GL administered utility EE programs across five states, 2010-13 cumulative kWh savings*

Energy Efficient Equipment: HVAC

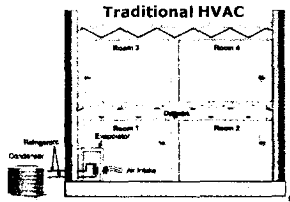
Significant savings to date, but compared to lighting, HVAC has higher hurdles – increased capital costs and complexity (can't just 'swap out' like lighting fixtures)

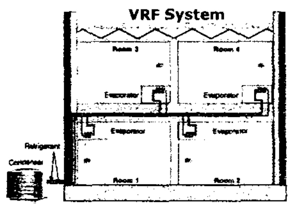
Mainstays:

- Variable Speed Drives: fans & pumps do not always run at maximum power, and neither should the motor
- High-Efficiency Chillers: when partnered with VSD's, can reduce cooling energy input by 30-50%
- AC Upgrades: Many options: unitary/split, AC/heat pump, ground/water source
- Airside Economizers: increase efficiency by taking in outside air - important for data centers & large facilities

What's Next:

- Maintenance & Operational Adjustments (e.g. Retrocommissioning)
- Energy Recovery Ventilation: reduce ventilation load by transferring energy between exhaust & intake airflows
- Variable Refrigerant Flow (VRF): extremely efficient, uses refrigerant piping rather than ducts



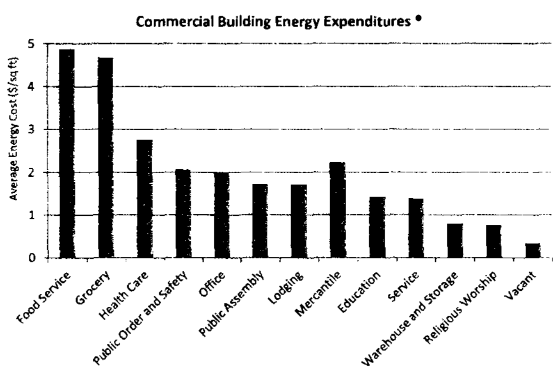


Energy Efficient Equipment: Food Service & Refrigeration

Small portion of total program savings, but a high priority – the food service & grocery segments have the highest energy cost intensity of all commercial buildings

Mainstays:

- Refrigerated case lighting
- Night covers
- Strip curtains
- EC motors
- Evaporative fan controls
- Anti-sweat controls

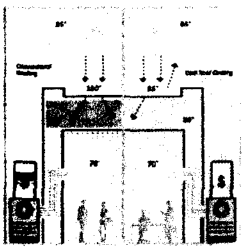


* Data from 2003 Department of Energy Commercial Building Energy Consumption Survey (CBECS)

Building Shell - Mainstays

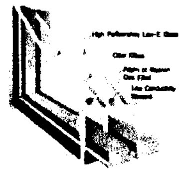
Cool Roofs

- Reflect ~85% of solar heat (compared to ~15% for traditional roofs)



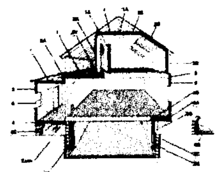
High Performance Glazing

- Improved coating, inert gas filling, & multiple window panes



Ceiling & Window Insulation

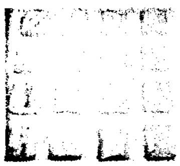
- Moisture and air leakage control – critical for new construction projects & major renovations



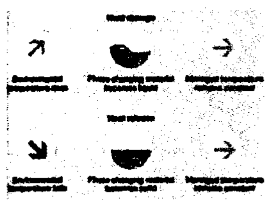
Building Shell – What's Next?

Phase Change Materials

- Material embedded in building walls & ceilings that change from liquid to solid to absorb/release heat

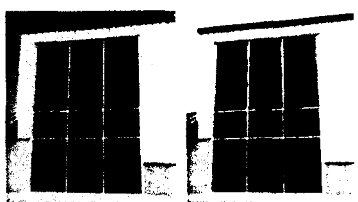


BioPCM © made from renewable plant resources such as coconut and soy



"Smart Glass"

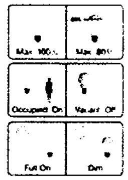
- Thermochromic: adhesive coating passively adjusts window as temperature changes



- Electrochromic: electric current controls window tint – can be manually adjusted

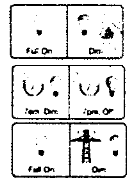
Boeing Dreamliner Windows

Controls: Lighting



Mainstays:

- Dimmable Ballasts & Fixtures
- Occupancy Sensors
- Daylight Sensors



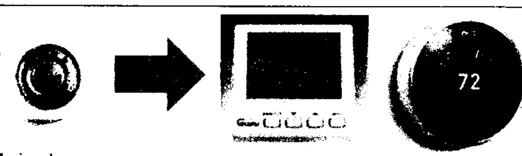
What's Next:

- Personal Controls
- Integrated Scheduling
- Demand Response

Example - Daylight Sensors

Lighting control images from Lutron

Controls: HVAC

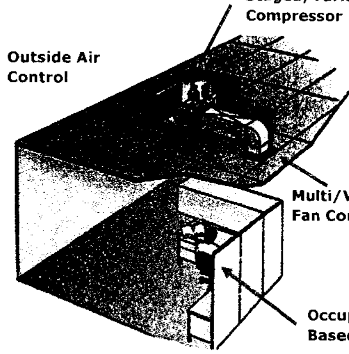


Mainstays:

- Demand Control Ventilation: ventilation based on actual occupancy, not assumed
- Programmable Thermostats
- Guest Room Energy Management: room occupancy sensors, key-card based sensors, & temperature setbacks
- Energy Management Systems

What's Next:

- Advanced Unitary HVAC Controls: regulate building temperate based on outside air and building occupancy (15-55% energy savings)
- Continued investments in EMS



Advanced Unitary HVAC Control System

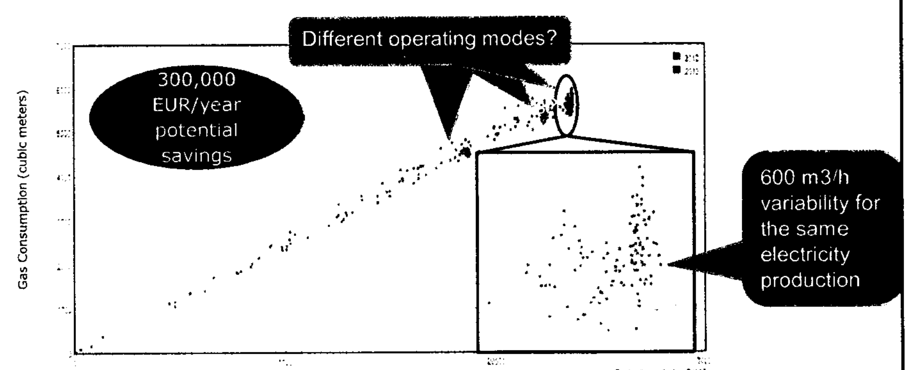
Energy Information & Analysis Systems: Diverse Functionality and a Crowded Market

Area	Function	Sample Firms
Building Controls & Audit Tools	Controls/Fault Detection	Hancock, 5TWENTY, BuildingIQ, lucid, MACH, SCIenergy, comverge, viridityenergy, Constellation Energy, enbala, ENERNOC
	Remote Audits	
	Audit Platform	
	Demand Response	
Analysis & Modeling	Advanced Modeling & Forecasting	FIRSTFUEL, Retroficiency, EnergyIQ
	Remote Screening	
	Benchmarking	
Program Implementation	Customer Engagement & Application Processing	wegowise, EnergySavvy
	Contractor Management	
	Performance Tracking & Monitoring	
Enterprise Energy Management	Carbon/EHS Tracking	SAP, SIEMENS, Schneider, CAP, ecova, urjanet, VERISAE, enablon, 360, SoFi Enterprise Sustainability Performance
	Procurement	
	Utility Bill Management	
	Building Portfolio Management	

Systems & Process Optimization: Behavior Change & Energy Use Variability

What causes variation in energy consumption for industrial & manufacturing facilities?

- Input & Output: outside temperature, raw materials, & types of products produced
- Process: Level of automation & ***influence by operators***

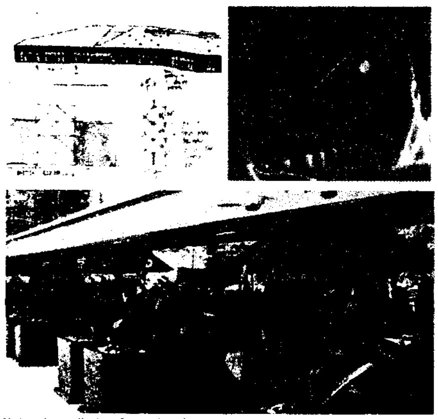


Pictured: high energy variability observed for electricity production at cogeneration facility

Systems & Process Optimization: Passive Technologies & Zero Net Energy

Passive Building Technologies

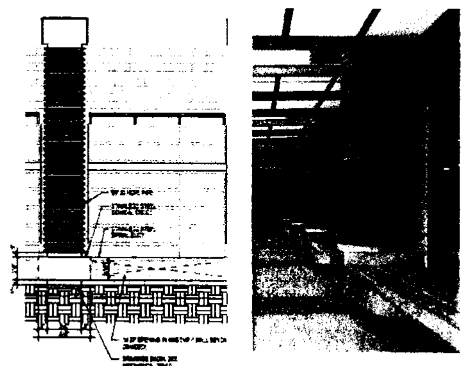
- Use of site location, sun, thermal characteristics of building materials, and air flow to minimize energy consumption



Natural ventilation from sketch to analysis to build for zero net energy office building in San Diego, CA

Zero Net Energy

- A building that produces as much energy as it consumes over the course of one year
- CA has set the ambitious goal that all new residential (by 2020) and commercial (by 2030) buildings will be Zero Net Energy



Shower Towers - Passive evaporative cooling from sketch to build

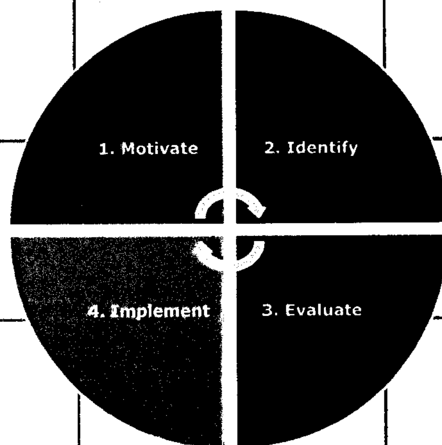
Key Market Barriers for Adopting Energy Efficiency Measures

- High information search cost
- High hassle and transaction costs
- Performance uncertainty
- Organizational customs
- Access to financing
- Split benefits (owner vs. renter, builder vs. buyer)
- Lack of buyer-seller trust
- Replacement timing: Lost opportunity

Energy Efficiency Project and Program Stages

- Engage
- Increase Awareness

- Assess
- Present Solutions



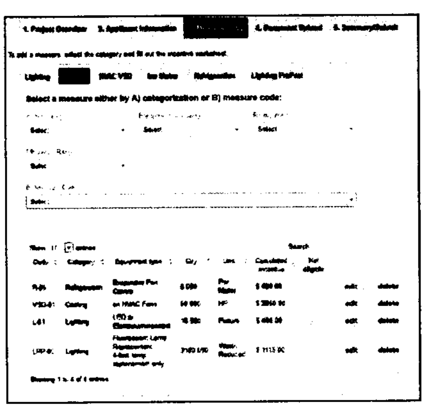
- Simplify Options
- EPC Support

- Assurance
- Verify & Certify

DNV GL: Continued Improvements in Program Implementation

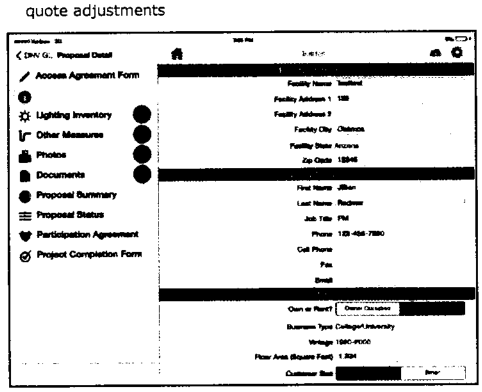
Online Rebate Application

- Streamlines application process, encourages repeat customers, & simplifies review process



Direct Install iPad App

- Enables contractors to perform an on-site energy assessment, calculate project costs, and make real-time quote adjustments



DNV GL:
Continued Improvements in Program Implementation

Contractor -> Trade Ally

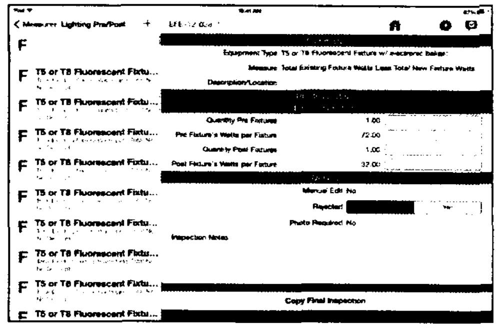
- Contractors are pre-reviewed & undertake training on program components
- Cost-effective marketing - contractors help to reach larger customer segments
- Local contractors = local jobs

DINOMAE "Do-It-Now or Meet-An-Engineer"

- Tool under development to streamline outreach efforts to large C&I customers
- Multiple-choice interview questions generate all potential efficiency recommendations by the end of a short interview
- Eliminate the need for detailed audit or engineering review

Site Inspection iPad App

- Allows inspectors to view details for all installed measures and document inspection results seamlessly



Questions ?

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510-853-2152

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SAFER, SMARTER, GREENER

HORIZON POWER SYSTEMS

Capstone Turbine Corporation
AUTHORIZED DISTRIBUTOR

Energy Efficiency Achieved With Microturbine Based Combined Heat & Power Systems (CHP)

Presented to the Arizona Corporation Commission

Horizon Power Systems
6/25/2014

Vito J. Coletto
Corporate Accounts Director

Today's Agenda

HORIZON POWER SYSTEMS

- Who We Are
- Overview of Combined Heat & Power (CHP)
- CHP Customer Classes
- Why CHP?
- Typical CHP Modes of Operation
- Overview of Microturbine Technology (CHP & MicroGrids)
- Next Steps for Arizona?
- Q&A

Who We Are

HORIZON POWER SYSTEMS

- **Capstone Turbine Corporation**
  - Founded 1988 – Commercial launch in 1998
  - World leader in microturbine design/manufacturing
  - 7,000+ units shipped worldwide
  - Over 35,000,000+ operating hours
- **Horizon Power Systems** is an authorized distributor of Capstone microturbines
  - Responsible for the great State of Arizona
  - 16 years experience with full sales/service capability
  - Over 50MW installed, with 10M operating hours and counting

Overview of CHP

HORIZON POWER SYSTEMS

- **Combined Heat & Power Systems or CHP is the simultaneous production of electricity and heat from a single fuel source**
  - **Majority are Natural Gas fueled**
- **High quality waste heat is used for space heating, DHW heating, process heating, pool heating, & space cooling**
- **Think of CHP as a prime power, energy management tool, reducing energy and operating costs at commercial and industrial facilities year round.**
  - **CHP is best for 24/7/365 energy intensive facilities**
  - **System runs in parallel with utility, connected on customer side of utility meter, supplying 50% or more of facility power 24/7/365**
- **CHP systems can be configured to provide both prime power and back-up power, replacing polluting & maintenance intensive diesel generators - attributes good for microgrid CHP also.**

Overview of CHP

HORIZON POWER SYSTEMS

- CHP systems are comprised of a number of individual components integrated into a complete energy savings/energy management tool for the end-user.
  - Prime mover (Microturbine)
  - Generator (integrated with prime mover)
  - Heat Recovery Equipment (Heat Exchangers)
  - Electrical & Mechanical Interconnection Equipment

- <u>Benefits of CHP for End-User Customer</u>
  - Energy Efficiency
    - CHP Total System Efficiency = Electrical Efficiency + Thermal Efficiency, with microturbines range is 65% to 80%+
  - Reliability
  - Economic
  - Environmental

Overview of CHP

HORIZON POWER SYSTEMS

- Largest volume of Natural Gas Fueled CHP Applications are 1MW and below

- <u>Conventional CHP "Prime Movers" for Natural Gas CHP</u>
  1. Reciprocating engine-generators
  2. Microturbines
  3. Fuel Cells

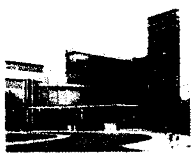
- Up-Front Capital Cost Comparison (High-level budgetary)
  - Generators: $1,000/kW - $1,750/kW installed
  - Microturbines: $2,000/kW - $3,000/kW installed
  - Fuel Cells: $5,000/kW - $6,500/kW installed

- In terms of system efficiency, reliability, maintenance, environmental and overall <u>LOWEST</u> total cost of ownership, <u>MICROTURBINES</u> are an excellent option for CHP applications

HORIZON POWER SYSTEMS

CHP Customer Classes

Large Retailers

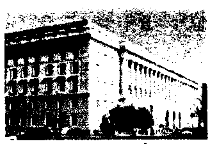


Hospitals

Telecom

Office Buildings

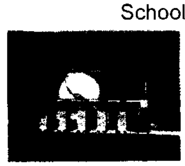
Hotels



U.S. Gov' t

Schools

Landfills



Waste Water Plants

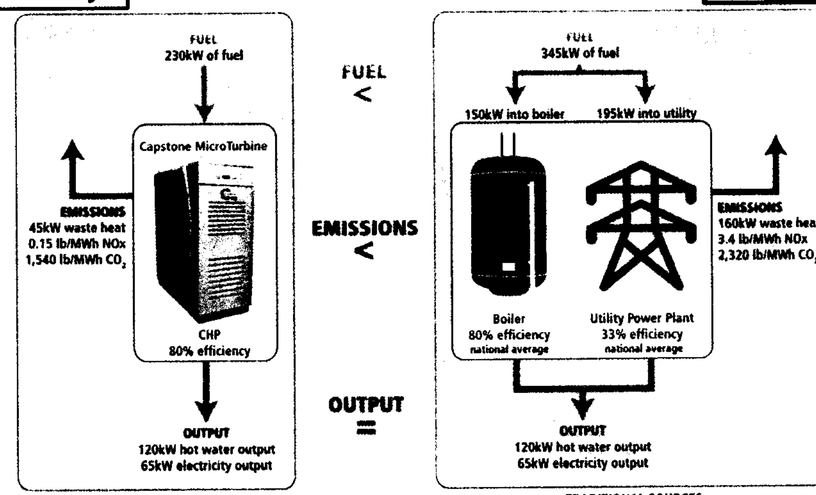
HORIZON POWER SYSTEMS

Why CHP?

To create the same power output, traditional sources use more fuel and have much higher emissions

Efficiency

Reliability

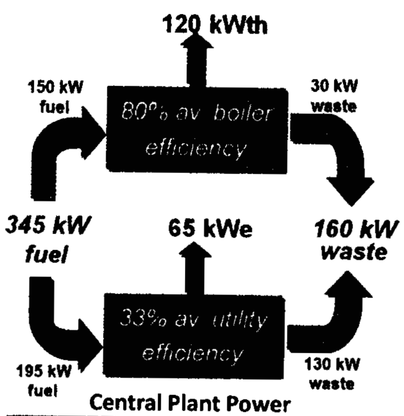


CAPSTONE MICROTURBINES

TRADITIONAL SOURCES

CHP-Exhaust Heat Utilization Drives Total Efficiency

Traditional Approach



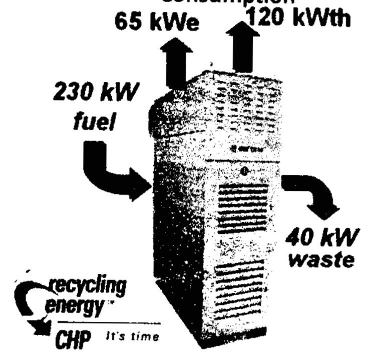
Central Plant Power

[redacted]

Source: EPA and DOE, see notes page for specific references

Capstone CHP

Distributed Power, at Point of Consumption



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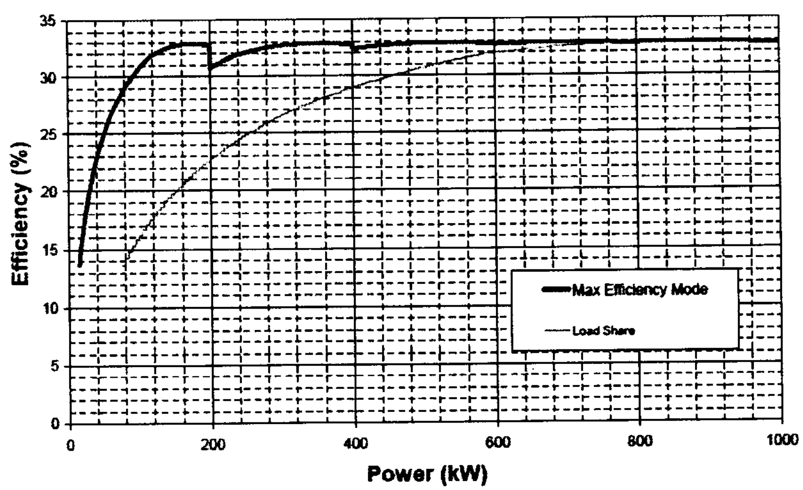
Energy Efficiency

- Benefits of Microturbine CHP Energy Efficiency
  - Lower operating costs
  - Reduced emissions of all pollutants
  - Increased reliability and power quality
  - Reduced utility grid congestion and avoided utility transmission & distribution line losses

HORIZON POWER SYSTEMS

High Part Load Efficiency

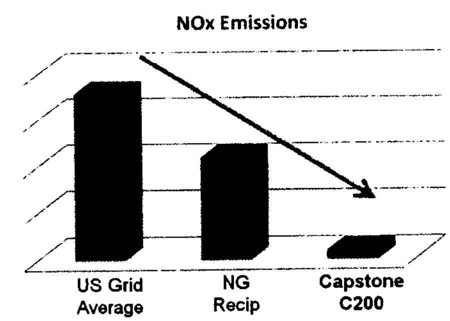


Allows efficient operation and very high turn-down

HORIZON POWER SYSTEMS

Clean, Green & Reliable Energy

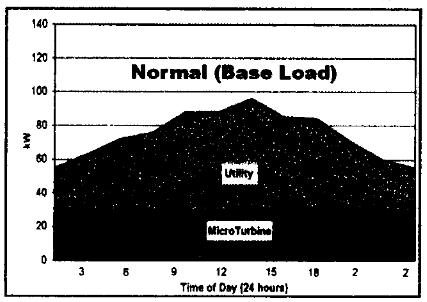
- Capstone emissions are less than 1/10th that of internal combustion engines
- Qualified by California Air Resources Board (CARB) – the world's highest emission standards
  - Extremely stringent emissions standard that exceeds the requirements of federal standards
  - First power generation technology to receive CARB 2008 Waste Gas Emissions certification for operation on landfill and digester gas
  - C30 HEV certified on diesel and natural gas

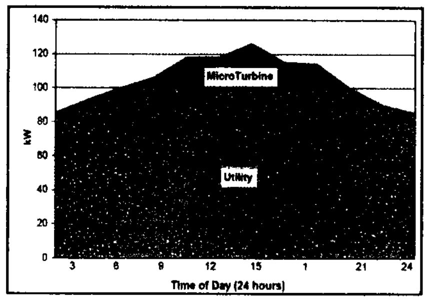


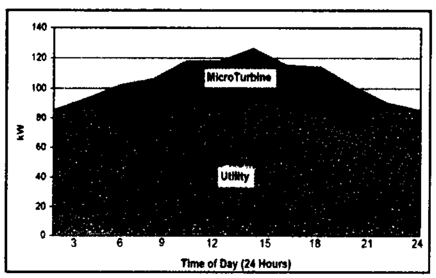
Source: EPA and ASME

Well positioned for global move toward increasingly stringent emissions standards

Grid Connect Modes Of Operation

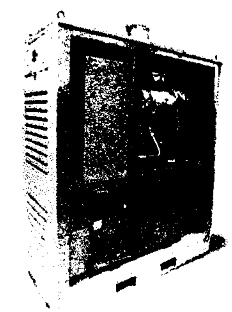






Microturbine Technology

- Microturbines are smaller scaled versions of larger gas turbine prime movers
- Power Range 30kW to 5MW
- Modular building blocks 30kW, 65kW & 200kW
- Microturbine Design:
  - Air bearing technology
  - ONLY one moving part
  - No coolants, oils or grease
- ***RESULT:*** **Minimal maintenance**



65kW Microturbine

Single Moving Part for the 30kW, 65kW and 200kW microturbine

HORIZON POWER SYSTEMS

Low Maintenance

Microturbine

- **6 hrs** planned maintenance per year
- Scheduled/unscheduled maintenance **$0.015 / kW-hr**
- Average uptime **99%**

8,000	Air/Fuel Filters, Igniter	Inspect, replace
20,000	Fuel Injectors	Replace
40,000	Engine/Generator, Fuel Injectors	Overhaul

Internal Combustion Engine

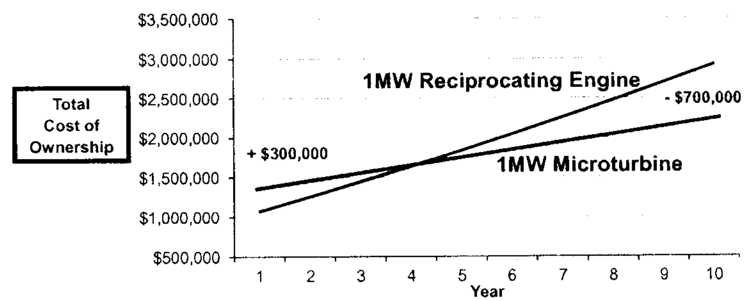
- **120 hrs** planned maintenance per year
- Scheduled/unscheduled maintenance **$0.018 to $0.022 / kW-hr**
- Average uptime **82%**

1,000 – 2,000	Air & oil filters, oil, spark plugs	Inspect, replace
1,500	Top end	Inspect
20,000	Top end	Overhaul
40,000	Bottom end	Overhaul

Significantly lower total cost of ownership: Maintenance costs are 25% lower on average.

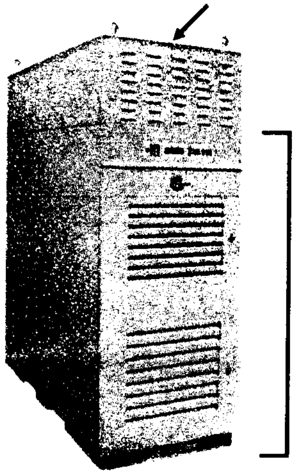
HORIZON POWER SYSTEMS

Lower Operating Costs



Other CHP Engines	Manufacturers	Why Microturbines?
Reciprocating gas engines	GE Jenbacher/Waukesha, Caterpillar/MWM, Deutz, Cummins, Tecogen	• Lower total cost of ownership • More environmentally friendly • Higher system uptime/availability
Gas turbines	Solar Turbine, Kawasaki	• GT has lower efficiency below 4 MW

Energy Efficient (CHP) Solution



65kW Microturbine w/Integrated HRM

- 65 kW of electrical power
- ~ 380,000 Btu/hr of hot water
- W 30" x D 87" x H 93"
- 2,820 lbs.
- **High Total System Efficiency**
- Outdoor Weatherproof Enclosure
- Quiet < 65dB @ 10m (with acoustic inlet hood < 60dB)
- Simple installation & operation
- Parallel multiple units as needed

Generator and Boiler in One Small, Compact Package

Microturbines for Microgrids

- Because of their efficiency, modularity, reliability, low maintenance, & highly available design, Microturbines are an excellent technology choice for microgrid applications:
  - Military Bases
  - College Campuses
  - Commercial Business Parks
  - Large Retail/Residential Centers
  - Remote, Off-Grid Applications
  - Can Operate Locally Grid Connected and/or Grid Independent

Next Steps For Arizona?

HORIZON POWERSYSTEMS

- Please reconsider & approve microturbine technology for the SWG CHP rebate program
  - Create an level playing field
  - Large combustion turbines have been approved
  - Gives end-user customers flexibility to choose the prime mover that is best for the specific CHP application
- Need for Consistent Statewide Utility Interconnection Standards
  - California & New York led the way
  - Avoid CHP project delays, unanticipated costs
  - Use IREC 2013 Model Standards as guidelines

Questions?

HORIZON POWERSYSTEMS

Capstone Turbine Corporation AUTHORIZED DISTRIBUTOR

www.horizonpowersystems.com

Arizona Corporation Commission Workshop on Emerging Technologies:

"The Impact of Geothermal Heat Pumps on Energy Efficiency and Peak Demand"

Presented by

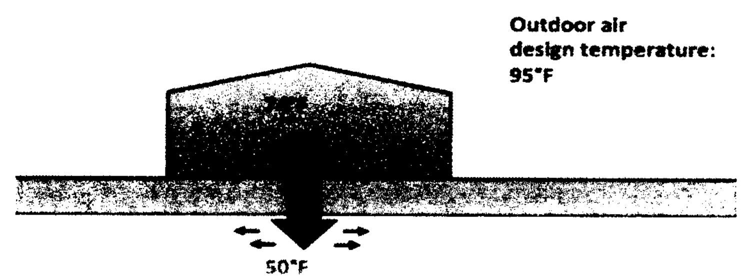
Morgan Stine, President of Green Earth Energy & Environmental, Inc.

Member of The Geothermal Exchange Organization

GEOEXCHANGE

Energy Efficiency Cooling Mode

Geothermal Heat Pumps have the ability to use the Earth as a heat sink, producing efficiencies ~50% greater than conventional HVAC methods



1 MW Geothermal = 1 "Negawatt"

- A typical 3-ton residential GHP can reduce summer peak demand by approximately 2 kW.
- 2 kW x 500 GHP homes = 1 megawatt reduction
- 1 megawatt not used = "negawatt."

Geothermal Heat Pumps Transfer Heat Efficiently in the Summer

300-400% Efficient

Geothermal Heat Pumps Transfer Heat Efficiently in the Winter

Purchased:
1 kWh of energy from the grid to operate the system

Yields:
4-6 kWh of energy for the building

Free:
3-5 kWh of energy absorbed from the earth

400-600% Efficient

GHPs are Both Renewable and Efficient

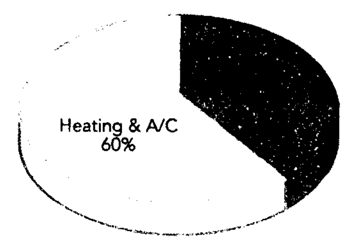
Renewable Energy Source

Uses the constant temperature of the earth to provide heating and cooling

OR

Efficiency Measure

Avoids the thermal loads of buildings and reduces energy needs



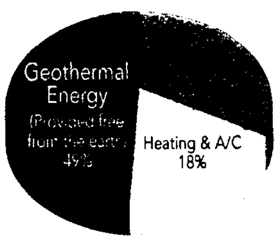
Energy Consumption of a Typical Single-family Home: Over 70% is used to meet thermal loads

State Incentives for Geothermal

Renewable Energy Source: 3 states include geothermal in their Renewable Portfolio Standard: Arizona, Maryland & New Hampshire

OR

Efficiency Measure: 39 states provide financial incentives or rebates for geothermal efficiency improvements.



Energy Consumption of a Typical Single-family Home: Cut in Half with Geothermal

Utilities Can Profit from Efficiency

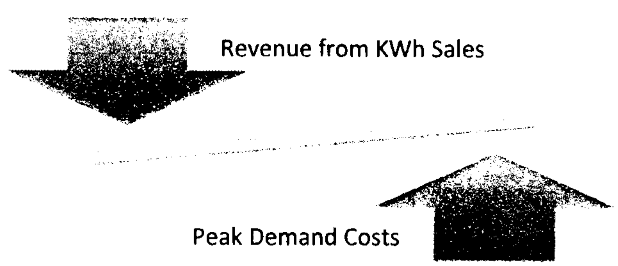
- ***"You want to create a situation whereby the reduction in cost exceeds our reduction in revenue...if the customer uses 10% less electricity, their bill has to go down by something less than 10%."***

-Ralph Izzo, Chairman and CEO of Public Service Enterprise Group (PSEG), an electric and gas utility holding company with over $32 billion in assets and 2.2 million electric customers in its New Jersey service territory

Source: Utilitydive.com, "PSEG CEO Ralph Izzo: Utility of the future will sell less electricity, but play 'more meaningful role'"

The Major Threat to Profitability of Utility Efficiency Initiatives

- Improperly structured incentives increase costs because reductions in kWh sales are not accompanied by peak demand savings



Measuring Effectiveness of Utility Efficiency Programs: SEER vs. EER

Seasonal Energy Efficiency Rating

- Measures a variety of temperature conditions to create an annual average efficiency figure
- Represents a climactic average not representative of Arizona's regional conditions

Energy Efficiency Rating

- Measures a specific temperature condition to show efficiency at one point in time
- Can be calculated for individual climatic zones to account for regional differences

The Best Metric for Structuring Efficiency Programs: SEER vs. EER

SEER

- Most common metric for efficiency programs, popularized by federal guidelines
- Not an accurate predictor of potential kWh reduction in peak demand conditions for most regions

EER

- Most accurate metric for predicting efficiency in peak demand conditions in any region
- Manufacturers test units at high temperature EERs, but often do not publish the data because of much lower ratings

Western Farmers Electric Cooperative:

A case study in efficiency program effectiveness

- Utility Profile:
  - 2/3 geographic region of Oklahoma, part of New Mexico, Texas and Kansas
  - 15% OK wind, 5 natural gas and coal generating facilities, some hydro
  - 3,600 miles of transmission line to more than 265 substations

WFEC Goal: Balance Supply Portfolio via Efficiency

wfec western farmers electric cooperative
A Touchstone Energy® Cooperative

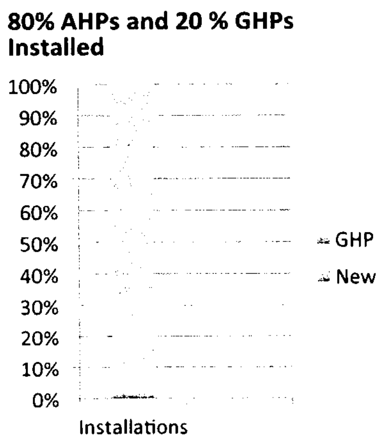
- Set goal to avoid 30MW new capacity by 2017 via peak demand savings
- $1,000,000.00 annual budget
- Compared to cost of new generation of $1,850+/kW or $55,5000,000
- Rebate program using SEER for air source and EER for ground source equipment

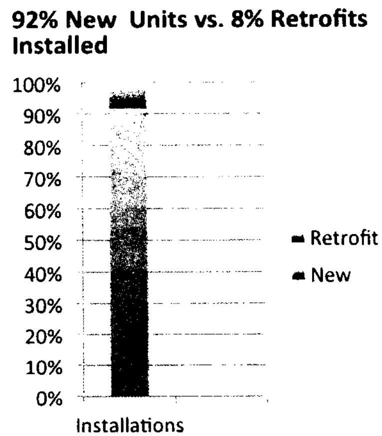
WF ROI Goals for 30MW Reduction

wfec western farmers electric cooperative
A Touchstone Energy® Cooperative

- Reasonable ROI
- Account for reduced energy sales and value of capacity reduction
- Subtract value of other factors including carbon offset, long term interest expense, and consumer and member cooperative value calculations

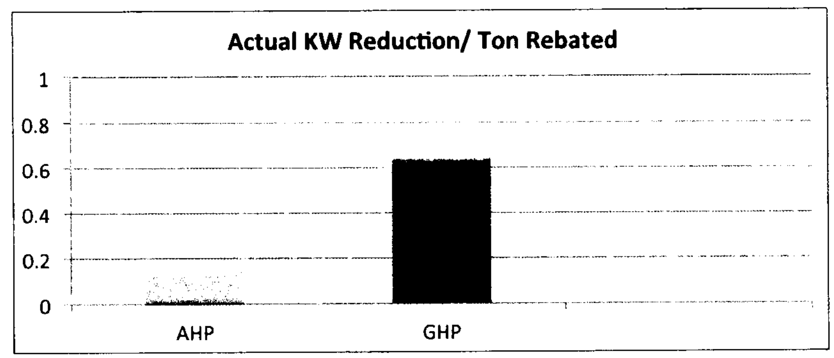
WFEC 2010 Program Results





2010 Program: Projections vs. Results

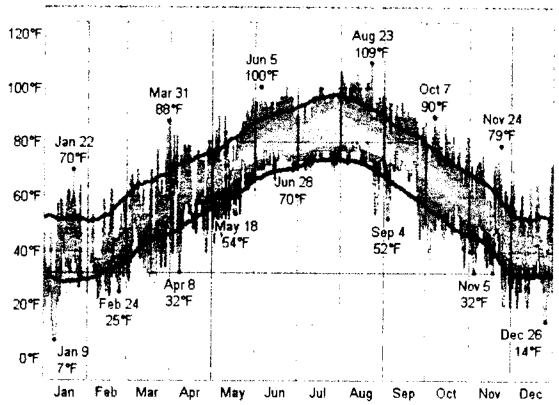
2010 Program	Projected kW Reduction	Actual kW Reduction	ROI
AHP	[illegible]	0.16 kW	Very long
[redacted]	[redacted]	[redacted]	[redacted]



WF 2010 Program Conclusions

- Record breaking heat of the 2010 Oklahoma summer with frequent 100F days
- Research into disappointing air source demand reductions revealed difference in SEER vs. EER on peak days

2010 Temperature Records for Western Oklahoma

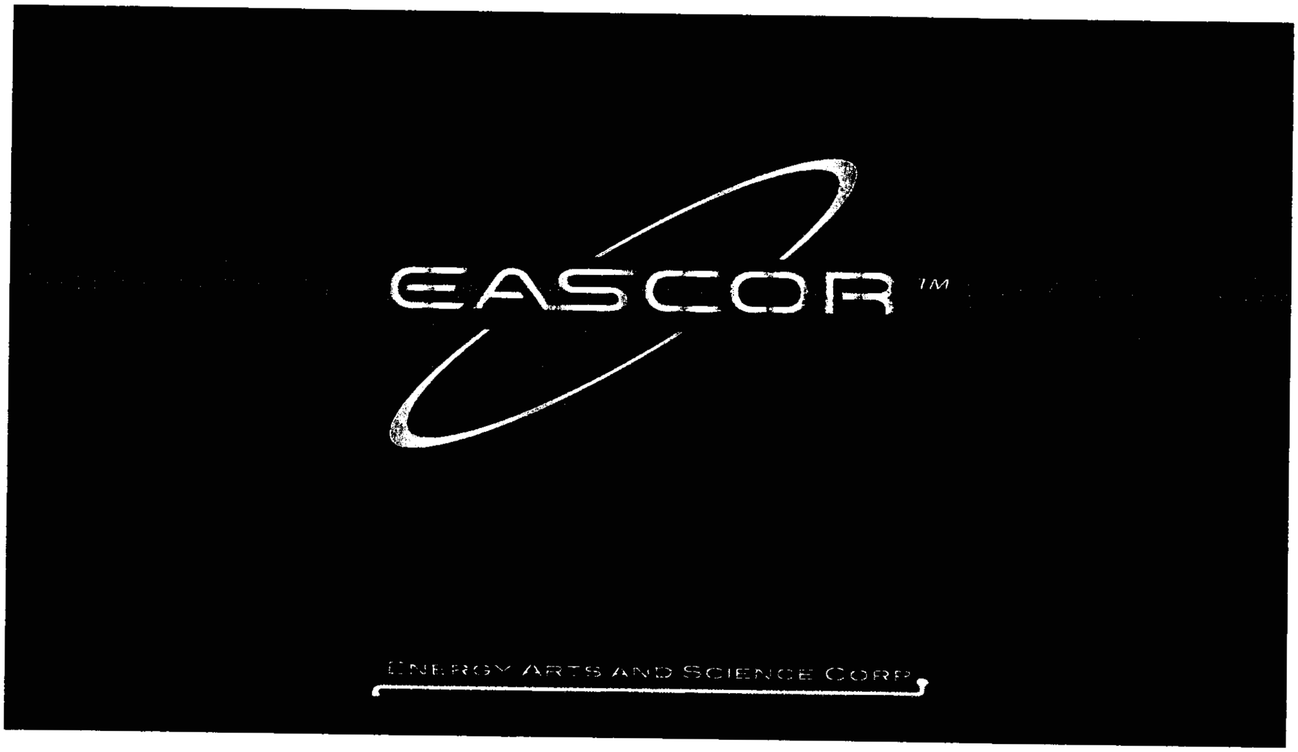


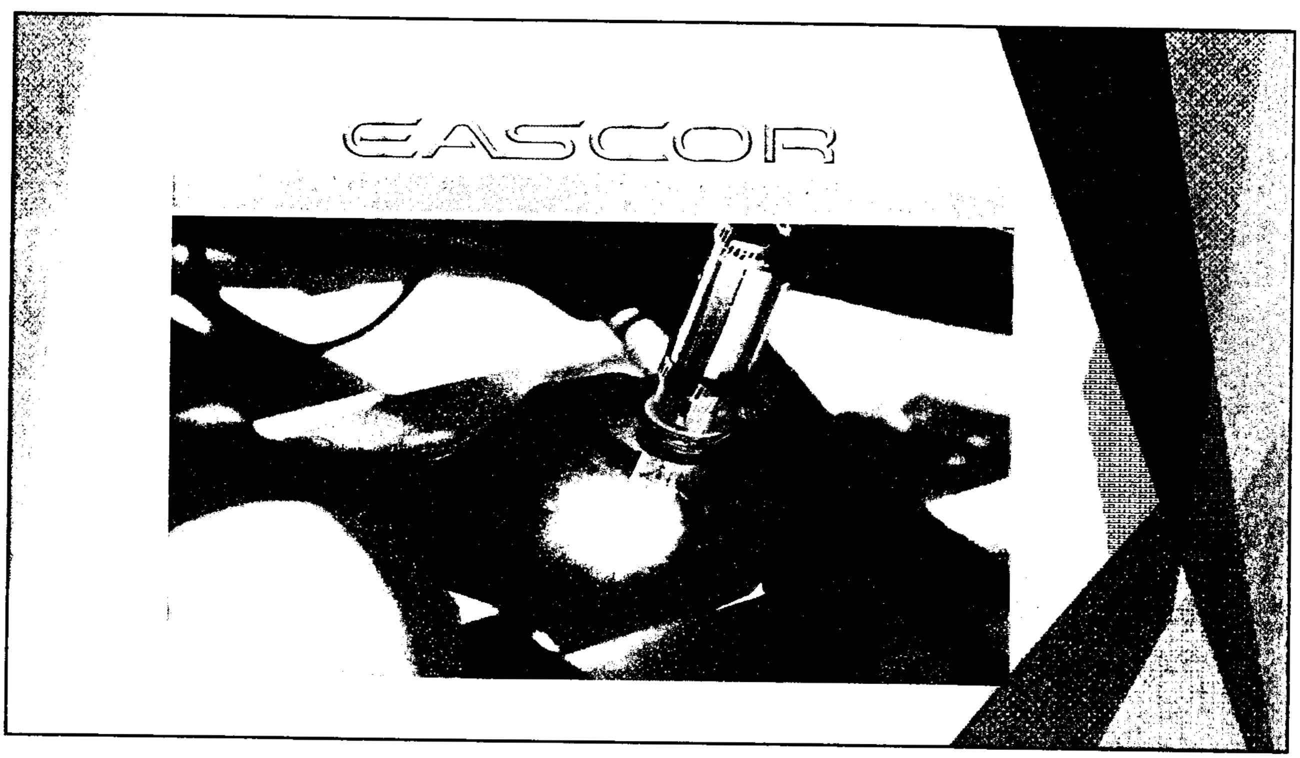
Source: http://weatherspark.com/history/29902/2010/Chickasha-Oklahoma-United-States

WFEC Program Changes

wfec western farmers electric cooperative
A Touchstone Energy® Cooperative

- Abandon SEER as a program rebate metric
- Increase the EER requirement of rebate eligible AHP equipment
- Flip rebate allocation from the 80/20 air source to ground source installation ratio of 2010 to 80% ground source for future years
- Address obstacles to increasing GHP installation
  1. Ground Source System Retrofit Costs
  2. Commercial and Residential Member Education
  3. Addressing Urgency Issues (time needed to address system failures)
  4. Changing the Target Market for Ground Source by Making it a Common Retrofit Opportunity


EASCOR TM
ENERGY ARTS AND SCIENCE CORP.


EASCOR

EASCOR

THE TEAM

Wes Moyer, Founder, President/CTO

Inventor of EASCOR's technology
and product innovator

Marti Hoffer, MBA, VP. Business Development

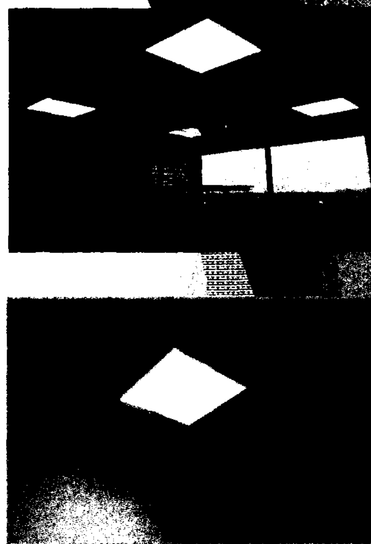
Founder/President Lumenomics LLC, a provider
of total light management solutions, LEED AP , LC

Sylvia Graebe – Business Development

USA & International markets

Samuel Pilli , Jesse Marquez Business Development

USA & International markets



EASCOR

The EASCOR Solution

Saving electricity by harvesting and
distributing daylight:

- High quality, FREE indoor natural lighting
- Rooftop collectors, hybrid light fixtures (diffusers)
- Off-grid (24x7 standalone) and On-grid

Internationally Patented technology

Commercial – Retail - Industrial applications

Experienced management team

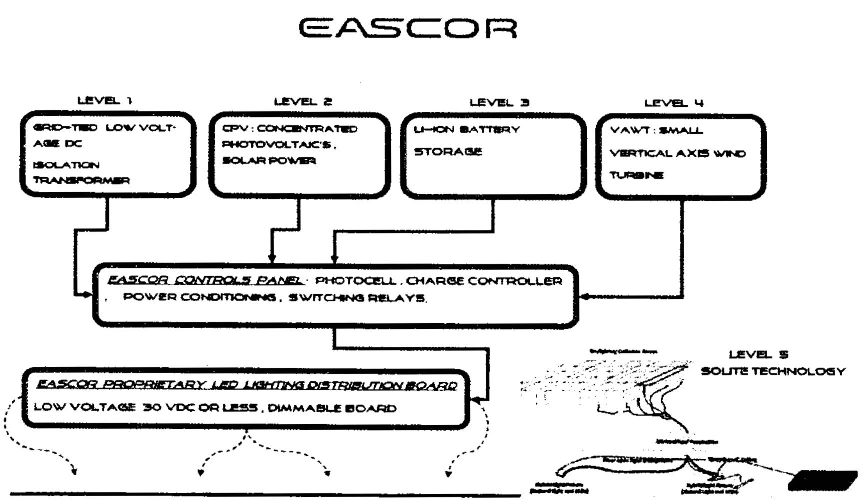
A Startup Open 2011 GEW 50 most promising ventures from around the world.

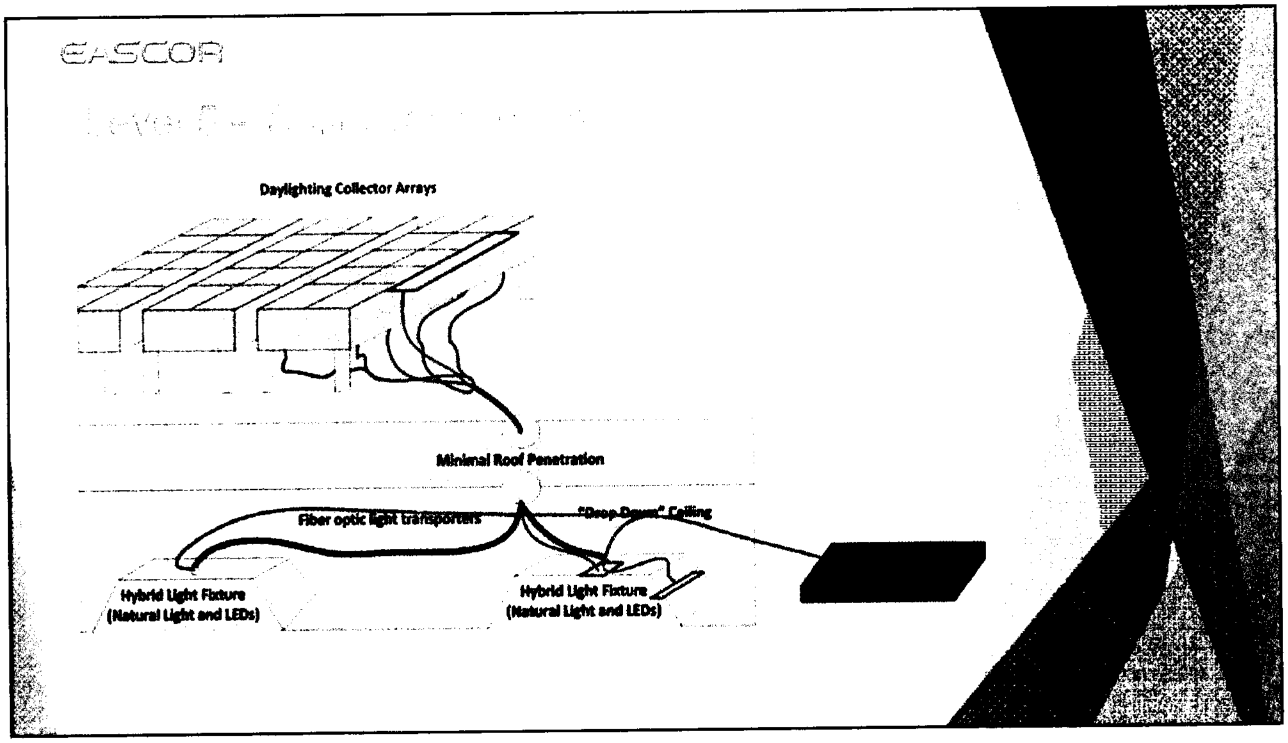
Customized installations are now available

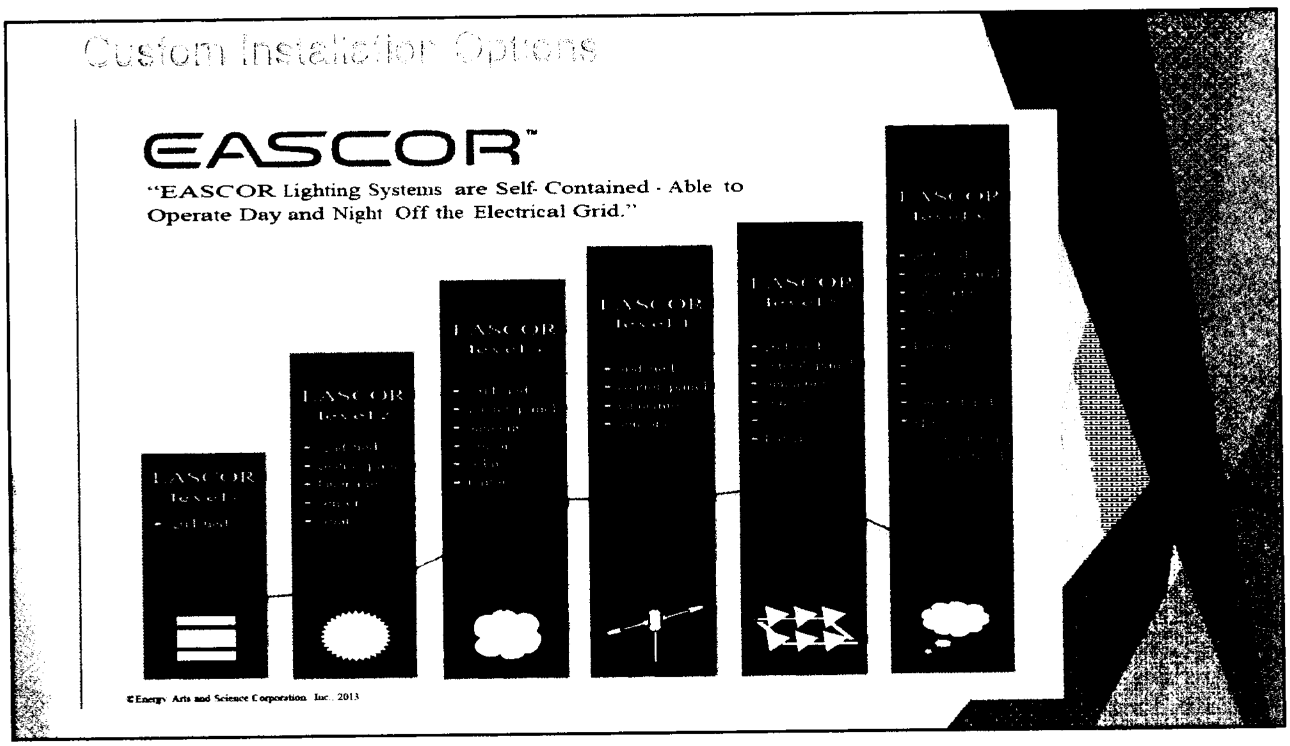
EASCOR

- Cutting edge hybrid lighting solution
- Green energy
- High quality lighting
  - Conventional fluorescent CRI = 3100
  - EASCOR lighting CRI = 5000*
- Five year maintenance and product warranty
- Eliminates 90% of current lighting expense

EASCOR




EASCOR
Daylighting Collector Arrays
Minimal Roof Penetration
Fiber optic light transporters
"Drop Down" Ceiling
Hybrid Light Fixture
(Natural Light and LEDs)
Hybrid Light Fixture
(Natural Light and LEDs)


Custom Installation Options
EASCOR™
"EASCOR Lighting Systems are Self- Contained - Able to Operate Day and Night Off the Electrical Grid."
©Energy Arts and Science Corporation Inc., 2013

EASCOR

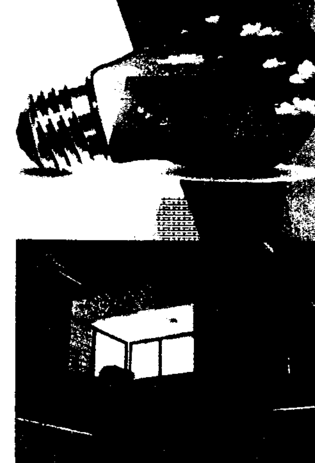
30 K SqFt Energy Audit EASCOR SYSTEM LEVEL 2	Current Cost	Total Off Grid Savings daytime	LED On Grid Savings	New Cost With EASCOR
Existing Lights: Wattage per Hr	24,000	24,000	7,260	
Cents per Kwh	$0.13	$0.13	$0.13	
Hours per day for Lighting	15	9	6	
Kwh usage per day	360	216	100	43.56
cost per Day	$46.80	$28.08	$13.06	$5.66
cost per Month	$1,404.00	$842.40	$391.72	$169.88
Per Qtr	$4,212.00	$2,527.20	$1,175.15	$509.65
Electrical costs per year	$17,082.00	$10,249.20	$4,765.88	$2,066.92
5 Year Electrical Costs	$85,410.00	$51,246.00	$23,829.39	$10,334.61
7 Year Electrical Costs	$119,574.00	$71,744.40	$33,361.15	$14,468.45
10 Year Electrical Costs	$170,820.00	$102,492.00	$47,658.78	$20,669.22

EASCOR

Free natural light = No lighting costs

Best cost/benefit. Example:
$2.5K for a collector array + 4-8 hybrid fixtures
1.2 kW/h electricity savings per array
Less than 1/2 the cost of conventional solar and others

- Modular: Easy install, scale up, maintain, no IR/UV
- ROI within 3.5 years without rebates and credits
- Reduces HVAC load/cost (90 BTU vs EASCOR 3 BTU), improves productivity, increases sales per sq ft,...



EASCOR

Day lighting throughout the day

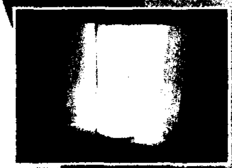
Highly efficient LEDs (135 lm/W) in each light fixture

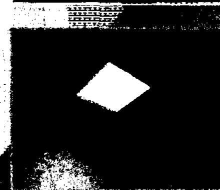
Indoor energy storage to power the LEDs

Dimmer switches and occupancy sensors

Filter out IR and UV reduce +15% of HVAC daytime load

Efficient, safe, low-voltage DC architecture when EASCOR is tied to grid





EASCOR

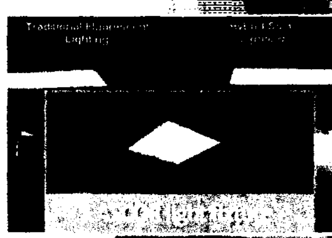
EASCOR pre-qualified properties

Commercial
- Retail: Automotive, banks, food/drugstores,
- Office buildings
- Schools and universities
- Medical/Healthcare
- Warehouse

Industrial buildings

Government buildings

Community centers



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